ENGINEERING NEWS

A JOURNAL OF CIVIL, MECHANICAL, MINING AND ELECTRICAL ENGINEERING

Vol. 59. No. 4. 220 Broadway, New York, January 23, 1908.

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GRADE REVISION ON THE CANADIAN PACIFIC RAILWAY IN BRITISH COLUMBIA.

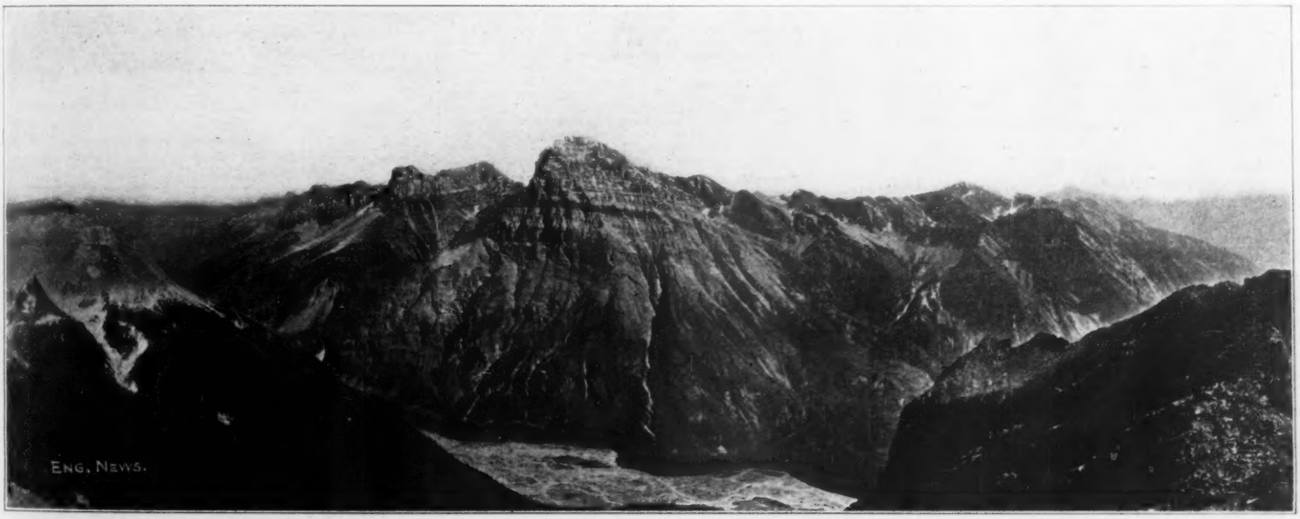
In making its way across the Rocky Mountain range, the Canadian Pacific Ry. has some extremely heavy work and some tremendous grades for a main line railway. The reduction of these grades is very desirable, to enable the increasingly heavy traffic to be handled to better advantage and with greater economy, but this involves difficult and costly reconstruction. An important piece of work of this kind is now in progress on the steepest part of the road, which is in British Columbia, on the west side of the summit.

In the eight miles between Hector and Field, B. C., there is a grade of 4.4% (compensated), with a length of 3.2 miles, giving a rise of 866 ft. For the protection of traffic there are three safety switches or catch sidings, to trap runaway cars or trains. This grade is to be replaced with a compensated grade of 2.2%, the actual rate of grade varying from 1.6% to 2.2%. The elevation at the summit of the grade remains the same, 5,168 ft. above sea level. About three miles east of this point is the summit elevation of the railway, 5,329 ft. The change in grade of course necessitates a considerable development, the new line being 8.2 miles in length, while the present line between the same points is 4.1 miles long. The development can only be obtained by looping the line back and forth, so that it ascends the valley by three lines at different elevations. It will be seen by the accompanying map that this development is very much as in a switchback line, but instead of using reversing stations to connect the different sections there are two connecting curves of 10°, with contained angles of 234° in one case and 231° 53′ in the other. On each loop will be a spiral tunnel; the first will be 2,890 ft. long, and the second (under Mount Stephen) 3,200 ft. long. The sharpest curve on the present line is 11° 30′, with a contained angle of 52° 16′. The map shows the location of the old and new lines.

This part of the line is confined in the comparatively narrow valley of the Kicking Horse River, and in order to get the extra distance required of 4.2 miles, the new line follows up the side of the valley on the lighter grade a little more than half the distance, crosses the valley and then goes into the side of the mountain in a tunnel through solid rock and makes a complete loop, coming out heading in the opposite direction. It then crosses the valley again and makes a corresponding loop, with a similar tunnel in the mountain. This heads it again in the general direction up the valley, where it rises on the lighter grade and joins the present line. The construction of the new line will necessitate the moving of 400,000 cu. yds. of solid rock, and the driving of three tunnels, 200 ft., 2,890 ft. and 3,200 ft. long. The two longer tunnels are spiral; they are circles of 573 ft. radius and have a grade of 1.6%, which makes them come out relatively 45 ft. and 48 ft. higher than where they entered. The whole circle of the spiral is not under the mountain, as part of it is made in each case before entering the tunnel. The upper line will cross the lower almost immediately above the portal of the lower entrance of the tunnel in each case, thereby doing away with an overhead bridge crossing. The portals will be in solid rock and the line above also benched in solid rock. Besides the tunnels, there is very heavy grading work in solid rock the entire length of the new line, some cuttings having 30,000 to 40,000 cu. yds. There are two crossings of the Kicking Horse River by steel spans. The new alinement will have considerably more curvature than the old line, owing to the loops, but the maximum curve will be 10° instead of 11½°.

The contractors have been on the ground since September. The work is already well under way, and will be continued during the winter; the climate is suitable for this class of work, the snowfall not being very great. Air drills will be used exclusively, and a large air-compressor plant has been established at each tunnel. The tunnel work will be carried on night and day from both ends, the work being lighted by electricity generated at the tunnel power plants. Steam derrick hoists will be used in many of the rock cuts, and dump cars will be employed for hauling the excavated material.

The importance of the improvement will be evident when it is stated that while four consolidation engines are now required to haul a passenger train of 10 to 12 cars or a freight train load of 710 tons, two similar engines will be able to take a train of 1,490 tons over the new line. The dangers of operating main line traffic on such a severe grade as 4.4% for over three miles will also be eliminated. The cost is estimated at $1,270,000, and the work is to be completed in November, 1908. The contract has



PANORAMIC VIEW OF PART OF THE KICKING HORSE VALLEY IN BRITISH COLUMBIA, SHOWING A PORTION OF THE CANADIAN PACIFIC RY., WHICH IS TO BE RECONSTRUCTED IN ORDER TO REDUCE THE GRADES FROM 4.4 PER CENT. TO 2.2 PER CENT.
Mount Stephen, in the Center of the Picture, Rises About 6,000 Ft. Above the Railway.

been awarded to Macdonnell, Gzowski & Co., of Vancouver, B. C. For plans and information we are indebted to the contractors and also to Mr. J. E. Schwitzer, Assistant Chief Engineer of the Canadian Pacific Ry., at Winnipeg, Canada.

The accompanying half-tone engravings of views along this part of the railway in connection with the plan and profile shown in Fig. 1, give a good idea of the difficulty of the work above described. The panoramic view on page 87, shows the railway winding around the base of Mt. Stephen. The summit of this mountain (10,523 ft. above sea level) is about 6,000 ft. above the tracks, which will give some idea of the scale of the picture. Below the railway is the torrent of the Kicking Horse River. The view is taken from the summit of Mt. Burgess, with Cathedral Mountain a little to the left of Mt. Stephen, and Mt. Field in the foreground on the extreme left. The view was taken by Mr. A. O. Wheeler, topographer, and for the photograph we are indebted to Mr. E. Deville, Surveyor-General of Canada. Mr. Wheeler has also sent us a number of beautiful photographs of this region, but showing mainly the summits of the mountains far above the railway, and these we do not reproduce. They were taken in connection with the Topographic Survey. Fig. 2 shows the railway at the base of Mt. Stephen and crossing the moraine of the lateral valley between Mt. Stephen and Cathedral Mountain. Fig. 3 (from a view furnished us by courtesy of the Canadian Pacific Ry.) is a view in the Kicking Horse canyon, after passing Mt. Stephen (which is shown in the background).

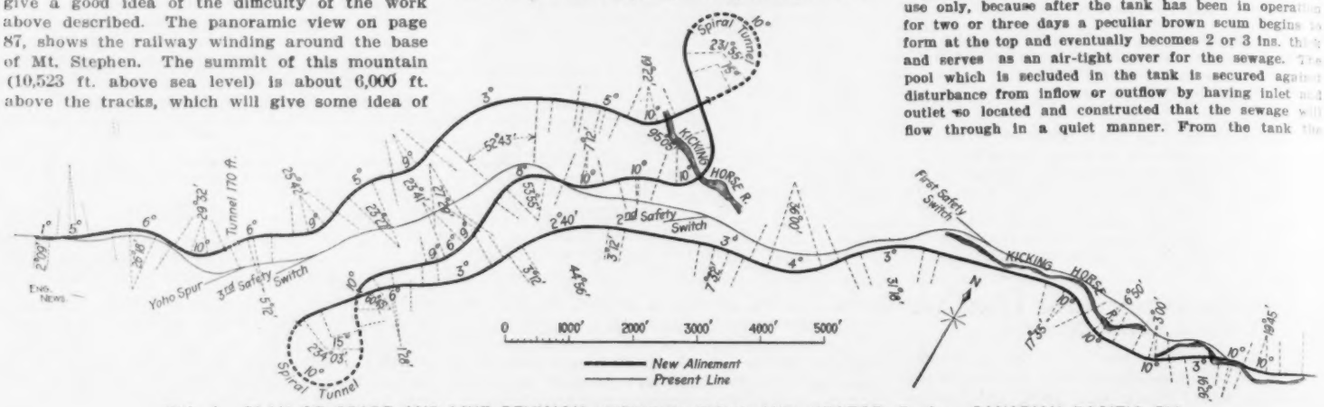


FIG. 1. PLAN OF GRADE AND LINE REVISION BETWEEN FIELD AND HECTOR, B. C.; CANADIAN PACIFIC RY.

Present line: Distance, 4.1 miles; Grade, 4.4%
New line: Distance, 8.2 miles; Grade, 2.2%

THE CAMERON SEPTIC TANK PATENT SUSTAINED BY THE COURT OF APPEALS.*

This cause comes here upon appeal from a decree of the U. S. Circuit Court, Northern District of New York, dismissing a bill for infringement of U. S. Patent No. 634,423, granted Oct. 3, 1899 (on application filed March 15, 1897) to Donald Cameron and others for "Process of and Apparatus for Treating Sewage." The opinion of the Circuit Court is found in 151 F. R., 242.

The opinion [of the court] below has quoted at great length from the specifications. [See Eng. News, March 28, 1907.] Since it may fairly be assumed that no one is likely to read this opinion without also examining that of the Circuit Court, those voluminous excerpts need not be repeated here, although in the progress of this discussion it may be necessary to quote many passages from such specifications. There are two groups of claims: those for a process, and those for an apparatus. The subject of discussion may be best introduced by reciting the five process claims which are relied upon, as follows:

(1) The process of purifying sewage which consists in subjecting the sewage under exclusion of air, of light and of agitation to the action of anaerobic bacteria until the whole mass of solid organic matter contained therein becomes liquefied, and then subjecting the liquid effluent to air and light.

(2) The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under exclusion of light and air and under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved.

(3) The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved *and then subjecting the liquid outflow to an aerating operation.* [Italics ours; indicate addition to Claim 2.—Ed.]

(4) The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, then subjecting the liquid outflow to an aerating operation, *and then to a filtering operation.* [Italics ours; indicate addition to Claim 3.]

21. The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until *a thick scum is formed on the surface thereof and* [Italics ours; indicate addition to Claim 2.—Ed.] a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under *the cover of said scum and* [Italics ours; words italicized are substituted for "exclusion of light and air" in Claim 2.—Ed.] under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until *all the solid matter* [Italics ours; words italicized are substituted for "the solid organic matter" in Claim 2.—Ed.] contained in the flowing sewage is dissolved.

The apparatus for carrying on this process consists of a tank, constructed of any suitable material, such as cement-concrete, shallow in comparison with its other dimensions, and in which the "pool of sewage" is located. It may be provided with an air-tight cover, for temporary use only, because after the tank has been in operation for two or three days a peculiar brown scum begins to form at the top and eventually becomes 2 or 3 ins. thick and serves as an air-tight cover for the sewage. The pool which is secluded in the tank is secured against disturbance from inflow or outflow by having inlet and outlet so located and constructed that the sewage will flow through in a quiet manner. From the tank the effluent passes into an aerator, where it is exposed to the action of the air and afterwards passes on to an ordinary filter bed. By reference to the claims it will be perceived that the second and twenty-first cover only so much of the process as takes place in the secluded pool, the first and third cover also the aerating operation; and the fourth adds the final filtering operation.

To a proper understanding of what the patent shows it will be necessary to postulate certain definitions.

Anaerobes are bacteria (micro-organisms) that are killed by air; they can neither act, multiply nor even exist in contact with free oxygen. They are also called the germs of putrefaction.

Aerobes are bacteria that die without air or oxygen. They are also called the germs of oxidation or of nitrification and their action is often called decomposition or fermentation.

That both these families of bacteria are potent in breaking up the solid parts of sewage matter was a fact long known to those skilled in the art. The patentee introduced a new word to the art: *septic*; he calls

FIG. 2. PART OF THE PRESENT LINE OF THE CANADIAN PACIFIC RY. AT THE BASE OF MOUNT STEPHEN.

*Full text of the decision and opinion of the U. S. Circuit Court of Appeals, Second Circuit (Judges Lacombe, Coxe and Noyes) in Cameron Septic Tank Co., of Chicago, Complainant-Appellant, vs. Village of Saratoga Springs, Defendant-Appellee. The opinion was written by Judge Lacombe. The decision of the lower court, in the same suit, was given in our issue of March 28, 1907.

his tank a septic tank. Defendant's expert concedes that the term was first used by Cameron and applied to the tank which he constructed and put in operation at Exeter, England. However this word may have been used subsequently by others, it should in construing this patent be given the meaning which the patentee gave to it. Examinations of the specification and claims shows that the definition contained in complainant's brief is in accord with them.

Septic action is the action of a colony of anaerobes preventing the accumulation of solids, unhampered by the presence of aerobes or oxygen or agitation.

The *septic* tank is the home and workshop of such anaerobic colony and its structural characteristic, as distinguished from other tanks, includes the roof of septic scum which is built by the anaerobes over the sewage current and remains as a permanent part of the tank.

The essential features of Cameron's process are these: He secures separate and successive action of anaerobes and aerobes on the organic matter of the solids in the flowing current of sewage. He first sets the anaerobes to work under such conditions that whatever aerobes were present in the flowing current as it enters the anaerobes' workshop are quickly destroyed, because with-

FIG. 3. VIEW ON THE CANADIAN PACIFIC RY. IN THE KICKING HORSE CANYON AFTER PASSING MOUNT STEPHEN. (IN THE BACKGROUND IS MOUNT STEPHEN.)

out air or oxygen they cannot live and at the outflow end of his septic tank there is absolutely none; tests mark free oxygen as zero. He cultivates this colony of anaerobes under conditions most favorable for their growth and activity, eliminating light, air and agitation while the slowly moving current is exposed to their activities. There is some oxygen present when the sewage flows in, although it has all disappeared before it flows out; and the current is not completely at rest, it flows in a quiet manner—were it stagnant the desired bacterial action would be disturbed and retarded. But there is a substantial absence from the current of oxygen and agitation. A curious result of setting the anaerobes to work under such conditions, after the septic scum has formed, is pointed out in the specifications:

> The micro-organisms increase at a fabulous rate, being fed by the incoming solid matter of the sewage until a mass of bacteria is developed sufficient to liquefy substantially all the solid organic matter contained in the sewage passing through the pool: . . . and the outflow is in the form of a liquid without solid particles of sewage. . . . The liquefied sewage as it leaves the septic pool has a slight odor, . . . and to relieve it of this slight odor it is subjected to an aerating operation.
>
> It is contended by the complainant that such effluent is peculiarly adapted for further treatment on a filter bed.

Thus treated, the colony of bacteria is continually recruited from incoming solid matter, maintaining such numbers as are sufficient at all times to quickly transform the sewage solids and the wastes of bacterial energy into a liquid effluent. This action is thus described by one of defendant's experts:

> In my opinion from six to eight weeks is required in which the liquefying action will be established to the extent of creating an *equilibrium* beyond which the solids will not accumulate on the bottom of the tank or on the top thereof: . . . an equilibrium between the accumulated solids in the tank plus those being constantly added thereto by the inflow of the sewage, and the bacterial activities whereby further accumulations are prevented.

Moreover, as the patentee states, "by this invention crude sewage can be treated for long periods without practically any sludge at all forming in the tank." In the plant at Saratoga, which treats sewage by the process above described—infringement of these process claims is not denied in defendant's brief—"the tanks have never been emptied since they were put in service July, 1903, a period of 2½ years, and no solid matter has been taken from them." In consequence, this equilibrium between the solids and the solid-destroyers, when once established, need not be disturbed, it will continue indefinitely. Having passed his sewage through the secluded pool, where it was exposed to anaerobic action, only, it is aerated and then subjected to aerobic action.

It is this method of dividing the process which complainant claims to be novel. Of its essential features the experts for complainant point out that *separate* action is necessary because the anaerobes cannot successfully act in conjunction with the aerobes, which are inimical to their multiplication and even existence; that *successive* action is necessary because the anaerobes prepare the organic matter for succeeding purification by the aerobes; that the *flowing current* is essential because it makes a continuous process, takes the matter out of the way of the anaerobes as fast as they are through with it and prevents the formation of toxins which would impair the value of the anaerobic produce for the purifying action of aerobes.

That the process possesses utility is beyond dispute: it eliminates the problem of removing "sludge," the solid matter which accumulates in the bottom of some sewage tanks and the disposition of which is often troublesome. Moreover, the defendant uses it and thus practically concedes that it is useful.

The process which has been described is the process which the patent indicates. The trial judge, however, reached the conclusion that the statements of the patent constituted a misdescription. He says:

> The patentee declares "The invention consists in certain methods of developing in a *flowing current of sewage* bacteria capable of dissolving the mass of solid organic matter contained therein and of subsequently utilizing the so-developed bacteria in liquefying the *mass of organic matter contained* in the flowing current." If this means what it says nothing of the kind is done. The bacteria or micro-organisms are not developed in the *flowing current of sewage* and cannot be effectually. They are developed in that part of the sewage which is at rest and which has been brought to a "stand still," secluded in a pool, and which must remain at a "stand still" below the flowing current until the bacteria are developed and have actually liquefied it.
>
> In our opinion this is error, and we believe the trial judge was misled by a diagram introduced by the complainant and made quite prominent in the argument. It gave us a misconception of the so-called septic action until in the course of the hearing it was corrected by counsel. It is an illustrative diagram showing the Cameron tank, shallow in comparison with its other dimensions, with inlet and outlet arranged so as to avoid agitation; arrows at inlet and outlet mark the direction of the flowing current. It displays shaded portions at top and bottom of the contents of the tank, representing the surface scum and the deposit. Such shaded portions occupy more than one-half the entire depth and are of about equal thickness at top and bottom. This is wrong, because the evidence shows that the total solids, when condition of equilibrium is established, vary between 20% and 25% of the total depth, and the scum is only a few inches in thickness—the total depth [of the tank.—Ed.] being about 8 ft. The diagram further displays a succession of wavy lines from top to bottom towards the center, each terminating in an arrow-head before reaching the center; they would seem to indicate the existence of a neutral zone of flowing current between them, in which whatever action the arrow-headed lines indicate does not take place. The condition of things indicated by this illustrative diagram is in accord with Judge Ray's description above quoted, but is not in accord with the testimony. The evidence as to what takes place in the septic tank of the patent is exceptionally persuasive. It appears that when Cameron announced his process to the world and built his tank at Exeter to put it in practice, he at once challenged the attention of the art. Sewage experts in England and elsewhere discussed his contribution as a startlingly novel one, and some of them came to Exeter to study its workings. In order to facilitate such study a glass inspection chamber was constructed in the tank, wherein an observer might place himself and, through its transparent walls with the aid of a lamp, study the process which was going on. One of complainant's experts made observations from such chamber and has testified to what he saw. Without indicating specific quotations it may be stated that the conditions within the septic tank are as follows: The deposit consists of a black peaty matter apparently solid at the bottom but gradually merging to a lighter or more mushy or frothy consistency on the upper strata. The upper surface of the scum is a brown leathery substance, immediately underneath it somewhat resembles axle grease, grading off to a mushy substance beneath. The current flowing between the sludge (deposit) and the scum consists of an already liquid portion in which are suspended particles of organic matter which because of their specific gravity remain suspended in the liquid and flow therewith. In this liquid portion also are particles which are detached by the anaerobic action from the floating or settled solids, and which particles cross the liquid in an interchange from top to bottom, or from bottom to top. The arrow heads in the illustrative diagram indicated these particles but did not show them *crossing* the liquid. This interchange is constantly going on, each particle flowing a certain distance with the current at each crossing, each particle being more finely divided at each successive crossing until it is finally merged in the liquid. The expert who had occupied the inspection chamber thus sums up the contention of complainant.
>
> Every particle of solid organic matter suspended in the liquid current of the septic tank finds itself closely surrounded by anaerobes already cultivated in the scum and sediment and completely at their mercy because every other influence is excluded by the "exclusion of light, air and agitation" which the patent so frequently repeats. Its liquefaction therefore does not have to wait for the cultivation of anaerobes, but commences immediately and proceeds with great rapidity. Afterwards

the liquefied particles find the aerobes all ready for them in the filter, where they in turn have full sway and oxidize and nitrify them, thus completing the purification. The complete separation of the anaerobic and aerobic actions is still further emphasized in the Cameron process by interposing between them the aerating operation, the action of which is to eliminate all the remaining traces of the anaerobic operation in the septic tank which might interfere with the aerobes.

It is not necessary to cite the evidence which complainant's counsel has collated to show that the action which takes place in the septic tank—"the workshop of the anaerobes"—*is* correctly set forth in the patent. One of defendant's experts, not incidentally but in a carefully phrased answer to a specific question, says:

I believe further that the action (anaerobic) which, as I have stated nearly always in my opinion has already begun before the solids have reached the tank, is *continued in every portion* of the tank both in the surface scum and the bottom deposit and *in the liquid contents.*

Our attention has been called to nothing in the record which controverts or qualifies this admission in any way and it must be accepted as true.

The question of anticipation is greatly simplified by a clear understanding of precisely what the Cameron process is. The crux of the question is stated in complainant's brief as follows:

In all processes of the prior art the aerobic or oxidizing action was continuous from the time the matter left the house as house-waste until the end of its purification as sewage. Cameron's separate anaerobic colony was the first break that was ever made in such aerobic action.

It is not disputed that anaerobic action was present to a greater or less extent in prior processes, but it is contended that Cameron was absolutely the first to instruct the art that the problem of removing sludge could be practically eliminated (irrespective of securing other advantages) by providing the anaerobes with a workshop in which they might act upon the solid contents of the flowing current, unhampered by the presence of air, oxygen, agitation or aerobes. With the question so closely limited the burden of comparing prior patents and publications with the Cameron process is materially reduced.

The process which, apparently, has been most relied on as an anticipation is that of Louis Mouras, who took out a French patent Sept. 22, 1881 (No. 144,904), an English patent (in the name of W. R. Lake) No. 5,391 of 1881, and a patent in this country Nov. 28, 1882 (No. 268,120). A study of these patents discloses what it was that Mouras contributed to the art. He did not undertake to treat the sewage of a system of sewers at the purification end, but to provide at each individual building a cesspool or scavenger for preparing the house-waste before it passes on to the sewer. His tank or scavenger might be of any form or any kind of materials, its inlet and outlet pipes are to be located below the surface of its contents, and the tank hermetically closed so that the outer air cannot enter the tank. The tank does not begin to operate until it is completely full of water. If then there is let in through the receiving pipe any volume whatever of water or feces, immediately an equal volume of water is expelled by the discharge pipe; the

discharge pipe never passes anything but turbid water holding in dissolution (in the English and American patents the phrase is "holding in suspension or solution") a certain quantity of matter coming from the decomposition and disaggregation of matter going on at the bottom of the tank.

By flushing the tank, as pointed out in a later quotation, it is cleansed without having recourse to the usual means of cleansing. Mouras says nothing about any bacterial action, but undoubtedly there was in his tank, as in all sewage tanks, some anaerobic action going on. That he made no provision, however, for securing conditions favorable to the action of the anaerobes, nor for separating their field of action from that of the aerobes, is manifest from the directions he gives as to operation —directions wholly incompatible with the exclusion of oxygen and of agitation upon which Cameron insists. He says:

For the proper working of the apparatus it is expedient to discharge into the receiving pipe, as much as possible, rain water and dishwater; in short, all water that can be disposed of, in order to facilitate in the tank the decomposition and disaggregation of feces and all other decomposable matters which may chance to be there. . . . It will happen, even in heavy showers, that the current occasioned by the falling water will produce an eddy which will make itself felt at a great depth in the tank, and which will expel from it, by the discharge canal, a great quantity of matter in dissolution, so that the cleansing of the tank will be accomplished up to the height of the eddy. [Manifestly this is a macerating process.] Furthermore, if the shower lasts a certain time, nothing but clear water will come out of the discharge pipe.

The tank has been simply flushed out. The promotion of this agitation and formation of eddies is facilitated by Mouras' directions to bring in the inlet pipe perpendicularly. Whether or not the object of this copious supply of water was to supply oxygen, such undoubtedly was its effect. It is not disputed that fresh water brings with it free oxygen. "Dilution," says one of defendant's experts,

consists in bringing the sewage into contact with a sufficient quantity of fresh water so that the dissolved oxygen which such water always contains can promote bacterial action. . . . Up to a certain point with an admixture of fresh water enough dissolved oxygen is available for the purpose. [Elsewhere he says] aerobic fermentation will take place in sewage to the exclusion of anaerobic so long as the supply of oxygen is present.

As we have seen, the only bacterial action which oxygen promotes is that of the aerobes; to the anaerobes it is a handicap and, in sufficient quantities, fatal. That oxygen is present in the Mouras tank is further shown by actual tests of tanks built, as defendant admits, according to the teachings of his patent; at their outlets it was found in large and varying quantities, while at the outlet of the Saratoga plant, built according to Cameron's teachings, there was none. The cesspool, therefore, described in the Mouras' patents differs materially from that described by Cameron, since it discloses no workshop for anaerobes separated from the aerobes, and maintained in anaerobic condition by the careful exclusion of oxygen and agitation.

Besides the three patents above cited, there is a mass of Mouras literature in the record, consisting of the observations of text-book writers and newspaper men upon his apparatus and process. The articles most relied upon in argument are those published in a periodical called "Cosmos" by a French abbé, one F. Moigno, who describes himself as "one of the common herd," quotes from Deuteronomy and two of the Evangelists and announces the invention of M. Mouras as "a complete solution of the problem, which for centuries had been an insolent menace hurled in the face of all humanity." He conjectures that

in the heart of the scavenger, the great agent of dissolution, of liquefaction would be hydrosulphate of ammonia or one of its congeners; or may it not be the vibrions or anaerobic bacteria which are destroyed by oxygen and which manifest their destructive activity only in vessels from which the air is excluded.

Of all these publications it is sufficient to say that, so far as they correctly describe the process which Mouras indicated, they point out only a tank in which aerobic action takes place, accompanied in some measure, in the deeper parts of the pool, by anaerobic action. So far as they contain suggestions, which Mouras did not indicate, they are (in the language of the Supreme Court in Seymour vs. Osborne, 11 Wall. 555)

mere vague and general representations. . . . (not) sufficient to enable those skilled in the art or science to understand the nature and operation of the invention and to carry it into practical use.

We find in them nothing to indicate that by changing Mouras' inlet so as to avoid agitation, by eliminating his large influx of fresh water with the eddies and the oxygen which it brought, one could establish a separate workshop for the anaerobes, and by that change modify the Mouras' process with beneficial results. None of them present "an account of a complete and operative invention capable of being put into practical operation," by establishing purely anaerobic conditions in a septic tank and maintaining them till an equilibrum was established which would permit an indefinite retention of the solids. Nor is this conclusion the mere inference of one unskilled in the art: This Mouras literature was published in the early eighties, but no septic tank such as Cameron describes was built until his first experimental structure was set up at Exeter, in 1895.

The next reference is to the patents and work of Scott-Moncrief, and of Dibdin, which, as complainants admit, are the nearest approach in principle to Cameron because they contemplated utilizing anaerobes and announced that "there is no need for the same amount of oxygen as has hitherto been believed to be necessary." But they fell short of Cameron's process, since they did not provide for having the anaerobes cultivated and worked separately from aerobes, oxygen and agitation. Two quotations from the Scott-Moncrief U. S. Patent (530,622) are sufficient to demonstrate this statement.

Sludge or deposit (which merely represents that portion of the organic matter which the organisms have not had time to liquefy) . . . may be removed from the concentrating compartment B when required by simply opening the penstock and raking out or flushing.

The agitation resulting from such an operation would destroy the septic conditions, which it takes weeks under the Cameron process to produce, and which if left undisturbed would continue indefinitely. [To quote further]:

In order to provide for the . . . aeration of the filtering material without stopping the continuity of the treatment . . . I provide a pumping apparatus as shown at R . . . for forcing air into the liquid contents of the filter at work . . . so as to supply oxygen to the organisms when necessary or advisable.

Dibdin in his Report to the London County Council says: "Firstly, the organisms must be supplied with plenty of air." But it is the distinctive teaching of the Cameron process that anaerobic conditions must be maintained in his septic tank and since oxygen is fatal to anaerobes he [Cameron.—Ed.] states in his patent that "it is of the utmost importance that means be provided for preventing contact with the air," while every one of his process claims includes a *pool secluded from air.*

The next reference is to a German patent to Müller (9,792 of 1878). His process is mainly intended for disembarrassing beet-sugar works from liquid waste, he says it may with slight modification be applied even to the treatment of household slops in towns. The only passage in the patent which is at all relevant reads as follows:

Whereas the former disinfecting methods had for their essential object to obviate as far as practicable any phenomena of putrefaction, corruption or decomposition, the process herein described on the contrary aims at the methodical cultivation of those small "leaven-like" organisms to the viability of which modern science has traced the so-called "self-unmixing" processes, namely acidification, fermentation, putrefaction, decay or the like, in accordance with the rules of physiology, with a view to bringing them into requisition in the task of precipitating out the liquid waste-substances or bringing about their complete mineralization (i. e. reduction to simple inorganic compounds). . . . Only in very few cases will it be necessary to actually sow the seed of these "leaven-like" organisms; they will mostly develop in amply sufficient quantities from the numberless germs in suspension in the atmosphere which are at all times ready to settle or "colonize" in a suitable soil, while their growth is further induced by the organic admixtures which are added for the purpose of supplying an adequate proportion of nutritive substances, in the form of meat, blood, glue, gluten, or human excreta, etc.

From the enumeration "acidification, fermentation, putrefaction, decay or the like" it is apparent that Müller had in mind both groups of bacteria, for the result of aerobes' activity is fermentation and the result of anaerobes' activity is putrefactnon. Indeed, the last quotation, referring to germ colonization with atmospheric surroundings, would seem to indicate that it was the aerobes which he expected to colonize. The description of his process is even more vague than the preliminary statement. There are no drawings, but, since he directs the use of three or four basins of at least one meter's depth, provided with a floating top-cover of porous material such as straw, etc., it is manifest that his patent did not suggest the establishing of anaerobic conditions in a septic tank.

The English patent to Adeney and Parry (3,312 of 1890) provides for keeping "the liquor (sewage) to be treated under suitable conditions for the rapid multiplication of micro-organisms." But they point out three methods only, one by chemical treatment, the other two by thorough aeration for the "purpose and object of developing and multiplying the micro-organisms in the sewage"—which certainly is not Cameron's process.

Besides the patents and literature above referred to defendant contends that anticipation is found in certain tanks which were built and used for sewage purification in this country prior to Cameron's date of invention. So far as their structural details are concerned, some of them at least closely resembled Cameron's apparatus; having the shallowness in comparison with other dimensions and inlet and outlet so arranged as to reduce the amount of agitation. Without stopping to consider some minor criticisms which complainant's counsel makes on these alleged anticipations, we may dispose of them in two ways. Tests for oxygen were made at all such as were still in operation when the testimony was being taken with the result that there was found at the outlets free and absorbed oxygen in quantities varying from 24% to 45%, while at the Saratoga plant, embodying the Cameron process, the record for oxygen at the outlet was zero. It further appears from the testimony that of these tanks those most resembling Cameron's were all cleaned and the sediment on the bottom removed, some of them frequently, some once a month, the one most relied upon "at least seven times per year and probably oftener." When it is remembered that all the experts on both sides agree that it takes from six weeks to two months to produce the anaerobic conditions which Cameron prescribes for his septic tank, with the scum and deposit of the proper thickness and the condition of equilibrium established which admits of an indefinite retention of the solids, it is quite apparent that these are not Cameron septic tanks; the prescribed conditions are swept away by the hands of the cleaner before they reach practical efficiency. On the contrary, at Saratoga there has been no removal of sludge, and therefore, no destruction of septic conditions for two years and a half.

Reference has been made to opinions in the first circuit in American Sewage Co. v. City of Pawtucket, 132 F. R., 35; 138 F. R., 811; 146 F. R., 753. Inasmuch as that litigation related to a different patent (U. S. 559,522 May 5, 1896, to Glover) the validity of which was not disputed, and the record before the courts in the first circuit was different from the one presented here, we do not find these decisions helpful to a conclusion upon the questions raised in the case at bar.

It is further contended by defendant that these five claims are void because the process they cover "is a process of nature and one which cannot be covered by any one." As we have seen before, the distinctively novel feature is the septic tank or separate workshop for the microbes. The Circuit Court, influenced, as it seems to us, by the conclusion which it reached that Mouras and Moigne disclosed all that Cameron claims, decided that the process claims could not be sustained, citing O'Reilly v. Morse, 15 Howard, 62, and other cases. We, however, are satisfied that Cameron was the first one to subject a flowing current of sewage to the action of anaerobes and aerobes under conditions which secured their separate and successive action, the action of the

segregation of anaerobes fitting the effluent for subsequent filtration and aerobic action; and by reason of such careful investigation he was the first to secure such specified conditions in the anaerobic colony that its capacity for its natural work had increased to such an extent that it became capable of disposing of practically all future incoming sewage that entered its workship without accumulating such a deposit of sludge as would require removal. This certainly involved "the use of one of the agencies of nature for a practical purpose." Risdon Locomotive Works v. Medart, 158 U. S., 77. The process is one which puts a force of nature into a certain specified condition and then uses it in that condition for a practical purpose. Bell Telephone, 126 U. S., 1, 534. Within the principles enunciated in the two cases last cited we are satisfied that Cameron's process as set forth in these five process claims is patentable. Infringement is not disputed.

THE APPARATUS CLAIMS.

These are Nos. 5, 6, 7, 8, 11, 12, 20, and 22; infringement is denied of 6, 7, 8, and 12. It is not necessary to quote them, [as] they are set forth in the opinion of the Circuit Court: each one of them contains as an element of its combination "a septic tank." Speaking generally and disregarding some minor variations of detail, it may be said that the several structural elements of each combination are old and that tanks with covers and with inlets and outlets arranged so as to avoid agitation were not broadly new. The contention of the complainant is this: Cameron introduced the word septic into the art, he defined it and it is used in the claims with the meaning he gave it. The septic tank, therefore, of these claims is the septic tank in which the septic scum and deposit are found, in which the equilibrium above referred to is established and in which the solids may be indefinitely retained. This is a peculiar structure, produced in part by the hand of man, in part by the forces of nature. After the labors of the mason, the plumber, and the iron-worker are over the micro-organisms are set to work and in the course of from six weeks to two months they add an inside floor and a roof of scum to the masonry structure, whereupon its temporary iron cover may be discarded and, then for the first, we have the septic tank of the claims. And because in the prior art there is no masonry (or other) structure which has been thus improved and modified by the action of anaerobic bacteria, this single element of "a septic tank" is sufficiently novel to uphold each combination into which it enters. The question presented is a most curious one; nothing analogous is found in any authority to which we are referred. The argument is ingenious and forceful, but in this case we do not find it convincing. The tank of the apparatus is, as the specifications state, "a suitable tank for carrying out (the) invention," i. e., a tank suitable for the colonization and cultivation of the anaerobes so that they may in time reach the stage of equilibrium with the solids. The apparatus claims were never, in our opinion, intended to cover any tank other than that which Cameron's human workman built. And this opinion is fortified by the following excerpts from the specifications.

> [The sewage] then passes through . . . the inlets into the tank A, in which it may be treated either chemically, bacteriologically, or otherwise, as desired; but it is preferable to treat it bacteriologically. . . . The invention also relates to a special form of tank in which a liquid is to be treated for the removal of solid matter by subsidence, flotation or otherwise. . . . This form of tank is illustrated in Figs. 4, 5 and 6. . . . In the arrangement shown in [these figures] the sewage or other liquid . . . passes into the tanks A, where as in the previous arrangement, it may be treated either chemically, bacteriologically or otherwise, as desired.

We concur with the circuit judge in his conclusion as to these apparatus claims.

The decree is reversed wtihout costs and cause remanded to the Circuit Court with instructions to decree in favor of complainant upon claims 1, 2, 3, 4 and 21, and in favor of defendant as to claims 5, 6, 7, 8, 11, 12, 20 and 22, without costs.

A PRACTICAL TEST FOR SET of reinforced concrete, to determine when it is safe to remove the forms and supports, was given by Mr. C. A. P. Turner recently in the course of an address to the Northwestern Cement Products' Association at Chicago, Ill. Commenting on defects of municipal building regulations for concrete work, he made the following criticism among others:

> They contain no practical working rules for determining when the concrete is in safe condition to remove the forms. Now, the rate of hardening of cement depends on many conditions: First, the character and condition of the cement itself, whether fresh from the mill or properly seasoned, etc., its composition, etc. Second, the temperature of the aggregates and water which are mixed with it to form concrete. Third, the temperature under which it is hardening. Fourth, the hygrometric condition of the air at this temperature. To formulate a comprehensive rule covering these variable conditions may be difficult, but it is easy to demand that concrete not frozen shall be set sufficiently hard so that if tested by driving a 20-penny wire spike into it with an ordinary carpenter's hammer, the spike shall double up after penetrating approximately one inch; and if the concrete is not sufficiently good to withstand this test after having had ample time to set, it is not good enough to remain and do business in a structure that may be deemed safe.

RIVETED LATTICE FOR RAILROAD BRIDGES OF MAXIMUM SPAN; A PLEA FOR A RETURN TO RATIONAL DESIGN.

By GEO. HUNTINGTON THOMSON,* M. Am. Soc. C. E.; M. Inst. C. E.

Concerning riveted lattice railroad bridges, the writer has written before. The first paper was prepared at the request of the late Sir Benjamin Baker and was read by him before Section G of the British Association for the Advancement of Science, at Bath, England, in 1888.†

That paper was presented in the interest of sane design and rational construction, trusting that structural integrity would follow as a possible sequel. It favored riveted lattice bridges for railroad service, and opposed structures with pin-connected articulations.

Subsequent experience has confirmed the writer's opinion, that the pin-connected system of structures possesses inherent defects by which it is ineradicably conditioned, and its use therefore limited for maximum spans; that it is inadequate to meet the demands of the future will be recognized by engineers in time.

In the year 1888 it was thought that an attempt to equal or exceed the span of the Forth Bridge would be made in the United States, and that the general scheme and details of design would follow the current and increasing practice, viz., trusses with pin connections, which, to the writer, was suggestive of disastrous possibilities.

ENGINEERING RESPONSIBILITY. — Nowhere in the world have the increasing demands of transportation called for the exercise of greater ability on the part of the engineer than in the United States. Transportation asks for direct ways over the most difficult obstacles, and we can but applaud the courage with which the engineer rises to meet these demands. But whatever the problem, he has ever before him a more or less definite responsibility which for the railroad bridge engineer is four-fold. He must

(1) Construct and maintain a substructure.
(2) Construct and maintain a superstructure.
(3) Maintain a relation between substructure and superstructure.
(4) Maintain traffic at all hazards.

In the event of catastrophe, he is at fault; no matter what the cause, he bears the burden. Possibly this sense of responsibility is really felt by those alone who have taken upon themselves the duties demanded by it.

STRAIN-SHEET ENGINEERING.—An eminent statesman has defined theory as everything that we can think of, and practice as all there is to think of. The strain-sheet does not embrace the whole content of thought involved in a rationally elaborated design. The function of the strain-sheet is entirely preliminary. The ultimate criteria of design are not within its province.

Quoting from the author's earlier paper, already referred to:

> The accepted method of dimensioning the numbers of a railroad bridge, from strain-sheet and unit-stress data, is not sufficiently comprehensive of the difficulties to be overcome, and it is not in accord with our mechanical intuitions and experience, and should not, therefore, be the only criterion of design. The design of the future should * * be liberal in the quantity of material used, and *judicious in its structural disposal.*

The strain-sheet is as necessary to bridge construction as algebra is to higher mathematics, and in about the same relation. The strain-sheet engineer points to his guide, unloads his responsibility upon it, and stands supreme upon the pedestal of sublime formula. This may not be done wilfully, but it is certainly done heedlessly. In the office, the strain-sheet is most prominent; in the field, where actual conditions must be met, we have practice, and the force of the statesman's definition is realized. Here the man, not the strain-sheet, is responsible.

A word as to Strain-sheet Engineering, as to what it connotes: A mode of thinking, followed by sequence of action, wherein fundamental repose in formulas and calculations derived from various highly conventional assumptions, coupled with a failure to recognize molecular motion, or structural motion, and a subsumption, explicitly, implicitly and tacitly postulated, that a perfection of mechanical workmanship obtains which is SOMETIMES realized, i. e., false assumption of hypothetical relations.

In the philosophy back of this there is open repudiation of the simple canons of logic, and there is a forgetting that the theoretical evaluation of the data or experience is impossible except under the acceptance of definite, universal and inexorable laws of cognition.

It is liable to lead to hazardous designing. Bridges stand or fall under natural laws; but in our notions of the law we are liable to err unless our thinking concords with the operations of the law.

In the present paper, the writer will modestly attempt to voice the consensus of opinions representative of the "lattice school" of engineers, as exemplified by their practice for sixty years.

THE LATTICE DOGMAS.

We believe that the art of the bridge engineer is still a profession and not a trade, notwithstanding the efforts of the academicals to the contrary. We belong to the rational, the logical school, dealing with matters in the abstract as well as in the concrete. We do not harmonize with the empirical school, which we consider represented nowadays by our brethren using pin-connected structures.

We do not approve of pin-connected articulation, not that pins in themselves are the source and embodiment of error, but we do object to the loose, slimpsy and, from a mechanical point of view, very objectionable details invariably (or with possibly a few exceptions) accompanying the pin-connected type of construction, which during erection of long spans requires constant adjustment and finally ends in an uncertainty as to the assignable distribution of stress.

We have tried pin connections, found them lacking, and abandoned them as early as 1848, Cubitts' Newark Dyke bridge being one of the last efforts in that direction.

We recognize the evidences of advance in pin-connected design of later years. We note that the system which began *without a single rivet* now makes use of rivets in greater quantity than the rivet engineer. The invasion of rivets began prior to 1870. We have watched, year by year, as detail after detail was borrowed from the lattice school, so that now about all that is valuable in the pin-connected system has been derived from the lattice type. The result is not a new school, based on fundamental principles or original ideas, but a collection of adopted ideas, and naturally the product is a hybrid, brought into being haphazard, influenced by the force of circumstances and environment. However, we are prepared to accept the pin-connected system when we can see clearly that it meets the demands upon it, when it can demonstrate a promise of structural life. Hybrids do not perpetuate their kind, yet other hybrids may be more progressive.

We predict the early adoption of one more lattice principle, viz., the full covering of compression joints, with 20% or more excess on the section of cover-plates and like excess of rivet section. Examples of riveted lattice bridges bearing out this point are everywhere to be seen. Riveted lattice bridges for railroads in the United States began with the bridge over the Mohawk River in Schenectady (finished in 1859; replaced about 1900-1) on the line of the New York Central R. R., George E. Gray, M. Am. Soc. C. E., Chief Engineer, and the late Howard Carroll, C. E., Assistant Engineer. In the Mohawk River bridge the compression joints were "fully spliced." The 1862-4 specifications of this railroad, also those of 1873, called for joints "fully spliced" with excess section.

The method of making the splices was always by double covers, as in Fig. 1. For instance, a ½-in. plate requires two 7/16-in. cover-plates. Hence, a joint of the kind shown in Fig. 2 can be admeasured, as to its value, as equal to but one web plate and no more; and considering the long rivets required and the indirect transmission of

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†Subsequently published in "Engineering" (London), Sept. 14th and 21st of that year, under the modified title of "American Bridge Failures."

stress involved, we would not be justified in placing a high value on this one plate.

In the matter of compression joints, the writer, in 34 years' experience with lattice bridges (and nine years prior experience with bridges of stone, wood and pin-connected bridges as well) knows

Fig. 1. Correct Splice; Single Plate with Two Covers.

of no failure to fully cover compression joints with excess section running from 20% to 100%. In brief, the joint or splice was the strongest spot in a top chord or other spliced compression member. From the first (1858) a top chord was finished in the bridge as a unit, i. e., one piece filling the lattice tenets of "continuity" as well as "co-ordination." We observe in the majority

Fig. 2. Improper Splice; Quadruple Plate with Two Covers.

of the pin-connected bridges much dereliction in this respect, indicating a refusal to recognize the principle of continuity and a lack of thought and study of a most important detail.

With the exception of the Mohawk River bridge, "butt" joints in lattice work in the United States were not faced until about 1885, all edges being sheared and *not in contact*. At present, in lattice design, the faced edges are a matter of mechanical finish, and not of the transmission of stress.

The principle of continuity in evidence in all old-fashioned lattice bridges postulates a compression chord as a unit of co-ordinate structural resistance throughout its entire length. There are no weak spots at the joints. We sometimes make use of double webs in compression members, but multiple webs NEVER, and for obvious reasons.

LATTICE AND ITS ABUSE.—We are pleased to see the users of the pin-connection system adopt our rivets and details, as well as some of our ideas. We are glad indeed to see the use, but to the abuse we make sincere and profound objection. We do not expect too much from rivets and so-called lattice bars, especially when there is a violation of one of the most strict rules of the lattice school, viz., that of co-ordination; and here we must protest! We decline to supply and support fundamental ideas save upon our interpretation of their meaning and application.

We come now to some of these fundamentals and define the term "lattice." The term is derived from a word meaning lathwork, laths intersecting and connected at the intersections, by which intersection a relation of interdependence of the pieces intersected results, with implied mutual assistance to all the pieces concerned and implied special support to the weaker pieces intersected, which are the pieces subject to compression. In Fig. 3 the laths extend from bottom to top horizontal pieces: the 14 × 3-in. plank lattice extends to and through the double chords; similarly the 3 × 3-in. angle-irons extend to and into the chords; all have a plurality of connecting media, such as nails, tree-pins or rivets.

Note the diagrams: Fig. 4, New York Central—Gray and Carroll, 1859-64; Fig. 5, New York Central—Hilton, 1865; Fig. 6, New York Central—Thomson, 1885.

In the Warren truss there is no exemplification of the lattice system; neither are the Pratt types A and B, Fig. 7, lattice. In B there is a junction of a web member and sub-web member, but no intersection giving special support to a web compression member and no continuity of one web member to both chords.

In all true lattice bridges, the earliest as well as the most recent, the compression members derive their resisting powers from the rigidity due to their solid intersection and chord connections, and not from the lacing of their structural parts. The terms "single lattice" and "double lattice" as used in the pin-connection system do not conform to our notions and practice, and we will not overestimate the strength of a so-called lattice member because it happens to be laced. Lacing bars in truss bridges are mere adjuncts or aids, not structural parts of a known or derivable strength. We are aware that two channels grouped together or spaced apart by staunch end cross plates and lacing when subjected to the gently imposed stresses of the testing machine "develop" a profound statement of nature's laws, which can be of service in cases of structures subjected to quiescent loading. We do not, however, accept this as a conclusion as to structural value, as do some designers, because we do not believe that empirical demonstrations are adequate to establish a conclusion of validity

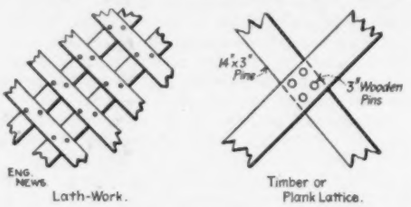


FIG. 3. LATTICE-WORK DETAILS IN TIMBER AND IN STEEL.

and importance. If we could assume a parity of conditions in the testing machine and a railroad bridge, we might view two channels laced as an integrant member; as it is, we see two separate compression members simply joined together.

In a column we sense the composite, a member built of component parts so assembled that a service stress imposed along one of its parts would also equally engage the whole. We have no testing-machine records of stress along one channel when that channel is attached to another by "lattice" bars. Briefly, we consider the lacing as little better than tie plates or spacers. In

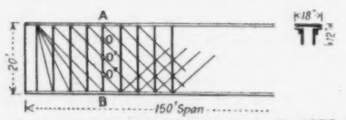


Fig. 4. Lattice Bridge, Gray & Carroll, 1859-64.

(Panels 5 ft. Solid plate portals. Full box end-posts. Top chord in continuity. Joints stronger than body of chord. Angles laced; no chord lacing. Web compression member A-B supported at three points 0-0-0.)

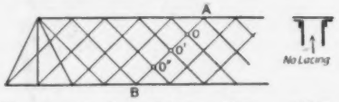


Fig. 5. Lattice Bridge, Hilton, 1865.

(Panels 10 ft. Through diagonal lattice bridge. Diagonal angles laced. Web compression member A-B is supported at three points 0-0-0.)

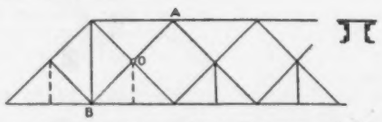


Fig. 6. Lattice Bridge, Thomson, 1885.

(Panels 30 ft., sometimes subdivided. Solid floors. The web compression members extend from chord to chord and are implanted therein, and are intersected at 0, by which the compression resistance is enhanced.)

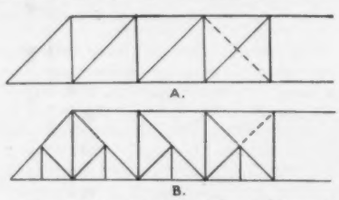


Fig. 7. Two Types of Pratt Truss.

compression members we do not increase the permissible unit-stress by virtue of its presence. Many old lattice chords are void of any lacing whatever (Fig. 8).

Whether in tension or compression we observe a lengthening or shortening of members under stress, the extent of which conforms to law. In compression, therefore, the lattice engineer uses solid shapes, or a combination of such, firmly grouped together in tubes, boxes, cells or fractions thereof (Fig. 9), for here he has material so placed that its value he is able to determine; he *knows* what they represent, structurally, i. e., what they are "good for."

As to the lacing in compression members, the lattice engineers do not regard this practice of sufficient structural value to warrant the spending of time and money in making refined experiments to arrive at the minimum quantity permissible to use. That is pastime which is the office and fad of the academicals and others who have not the responsibility of human life. "The fads of to-day are the errors of to-morrow." A theory may be sound, but not all the theories evolved since mankind began to think have been so, and the application of a theory may not be advisable when the conclusion to be drawn must be absolutely valid.

To the lattice school of engineering, the confidence reposed in lacing as a factor in structural aggregation by the pin-connection engineers is as inexplicable as it is astounding. We will not give lacing a derivative value, nor use it save in tension members under live load, and here its amount often exceeds that found in the compression members of pin-connected bridges.

THE UNCERTAINTIES OF THE EYEBAR.—Fatigue due to repetition of stress is a recognized fact in the character of steel. The pulling of an eyebar to destruction tests that particular bar *after a fashion*, but there is nothing here simulating repetition of stress. Eyebars of wrought-iron that had been subjected to repeated loadings in a railway bridge, placed in a testing machine, broke in the eye under a stress *less* than the elastic limit of the bar, while selected bars pulled at the time of manufacture gave highly satisfactory tests in the eye. We think this test might be applicable to steel bars. To give an eyebar

Fig. 8. Chords of Lattice Bridges, No Lacing.

stresses by means of a testing machine similar to those received in service (if it could be done) might take years. The fact that eyebars break in the body of the bar in single tests is no guarantee that repeated stress will find failure there.

It is a lattice tenet that the material joined by rivets should be virgin rolled; there shall be no forging except in the rivets. We object to the forging of the eyebar, because of the internal molecular stress set up, the extent of which may not be known, nor eliminated by annealing.

Fig. 9. Sections of Compression Members.

Before the eye is thrown into stress a mere contact of pin and eye is conceivable, as at *a*, sketch *A*, Fig. 10. After the bridge is free of its falsework, another contact may be conceived, extending over the zone *b-b*, sketch *B*, in Fig. 10. This contact may be assumed as a constant one in time and space, the bar being in its normal or usual state of quiescence, and the bridge carrying no load. Now, add the condition of a moving train-load. Here we may safely assume a sudden contact which extends the bearing of the eye on the pin to *c-c*, sketch *C*. The train having passed and the load removed, there is a return to the constant contact of sketch *B*. Here is a double deformation of the eye, with double molecular disturbance, imposed upon material already under internal stress due to forging, imposed upon material known to suffer from fatigue under

constantly repeated stress, imposed in such a way that we turn to testing machines for a conclusion from which we may evolve the law of its application. Can any one tell the effect of repetitions of stress upon the molecular integrity of the eye? Can anyone proportion or design an eye which shall safely balance the decreasing elastic qualities of the steel? Can the eye always withstand this stress? It is not opinions, but proofs,

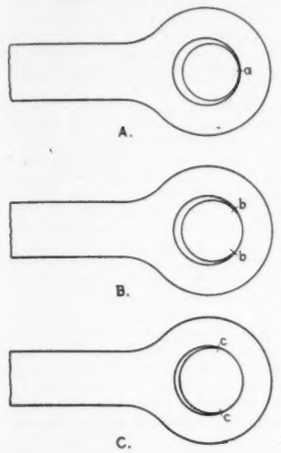


Fig. 10. Diagram Showing Changing Contact Between Pin and Eye.

that should answer these questions, for they are as vital as human life, and as important as the mighty dollar.

A recognition of these conditions is evident from the designs of eyes such as Fig. 11. The late S. S. Post, inventor of the "inflexible truss," thought out the problem and selected the shape shown by Fig. 12, as meeting in a measure the molecular distortion of the eye.* The late Charles Hilton, C. E., specified the eye form shown by Fig. 13, and described it thus:

> Eyebars when used for tension members, either in the chords or webs of braced girders, shall be made of flat bars, and the proportion of heads and pins shall be as described below. The heads to be elliptical in form with the longer axis in prolongation of the center line of the bar. Calling the width of the body of the bar 1, the diameter of the pin shall be 0.75, the longer axis of the head 2.75, the shorter axis or width through center of eye 2, and the radius of the curves of the shoulders connecting the head with the body of the bar 2.
>
> Other forms of eyes may be used, provided the proportions thereof, as compared with the body of the bar, are not less than above specified. . . heads of eyebars in no case to be thinner than the body of the bar.
>
> Parties submitting designs . . . will be required to describe the method . . . enlarging the ends of eyebars, whether by upsetting or welding . . . upsetting by pressure will . . . be preferred.

Tests of very large eyebars of recent manufacture show actual distortion of the eye with accompanying permanent set under stress less than required by actual service. We stand aghast at the complacency with which such a matter is received. The rejection of the eyebar years ago by the English engineers (who called them links) had its origin with the doubts concerning the elastic persistence and enduring qualities of forged work under cross-strain.

CONCLUSION.

"Formulas are mere tools for the intellect to make use of, they can never take its place." [Dupuit, "Etudes sur les Mouvements des Eaux."]

The law of nature is the one changeless element in the history of the universe. To formulate this law is the problem of the human race. Great minds have begun the compilation of its statutes, and with each generation another chapter is added. Theories stand or fall according to their ability to account beyond question for the facts in nature. Preeminently, among all professions, the engineer must deal with facts. His ability may lead him through sublime flights of mathematics, to conclusions most assuring. His more practical brother sets about to ascertain the fact in nature and generally finds, if he finds anything, a sad discrepancy between unerring mathematics and obstinate nature.

*Parenthetically it may be mentioned here that the "inflexibility" of the Post truss is due in a measure to an eye that had little stretch under load.

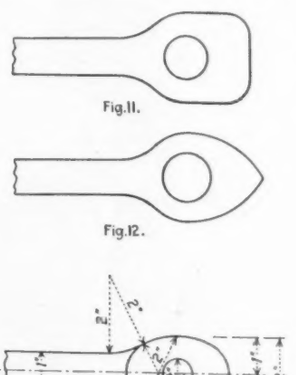
The mathematical formula is not formative, not in itself creative, nor does it establish the law of action followed by nature's forces. Formula may present a truthful statement of nature's laws, but it also may not. The constant use of blind formulas breeds a condition of mind closely resembling a mental hallucination. Hallucination will not bridge chasms nor maintain traffic.

Correct thinking, rational ideas embodied in practical designs having members assembled by the use of such formulas as we know to be safe tools; these are the faculties which the engineer who would build truly and in line with nature, must employ.

It frequently requires great catastrophes to bring home the warnings expressed by differing opinions. To those who have attained a position too exalted to be reached by criticism, we would point out the stricken wives and families of men who trusted their wisdom, of wives and families whose grief is the fiercest criticism that can reach the throne of responsibility.

Is it necessary to abandon great engineering undertakings? *No—get close to Nature.* Use only so many of her laws as we can truly decipher by the aid of mechanical tests truly applied. This is the sum and substance of the principles employed by the lattice engineer. To briefly outline them:

(1) Designs must be based upon rational common sense and practical conclusions, meeting all conditions involved, not theoretically, but practically. Any conclusion to be acceptable, in an engineering sense, must be complete in its derivation, based upon adequate and comprehensive premises. There must be a coherence of ideas, purpose and adaptability to ends manifest in the design, and above all, the design must be consistent with the demands upon it.



Figs. 11-13. Three Designs for Improved Forms of Eyebars.

(2) In all details, joints, splices," general assemblage, be sure first of strength, practical not theoretical strength, and let economy be second.

(3) To this end the engineer handles forces primarily and materials secondarily. It is possible to so adjust these forces that they shall pass through materials of a known strength in a known way, and thus, and thus only, can the result of construction be absolutely assured.

(4) Rolled steel has a strength which can be measured. The splicing and joining of this steel may be made stronger than its body. Moreover, by means of these joints, the entire structure may be made rigid and least liable to structural motion and repeated overstress; these repetitions being a fatal attack on the life of the material. Some of the earliest lattice timber bridges are doing duty to-day and those that have failed have given ample warning of their weakness.

With our increased knowledge of handling forces, with our improved material, we can build bridges with spans of 2,000 ft. and over on the lattice principle of design, and this without risk of erection, without making use of any untried principle, or any untried combination of shapes. The design may be thoroughly American and we shall find among lattice engineers men of abundant executive ability, energy and courage to perform the work.

All this was covered with emphasis in the remark of the late Sir John Fowler, made to the writer while standing on the Forth Bridge in 1889: "The Americans will exceed this span."

Quoting again from the writer's earlier paper referred to at the opening of the present article:

> That the ideas presented herein will meet with the approbation of any considerable number of his professional brethren in America, the writer does not believe.

In the light of the greatest bridge failure known we present this plea again for rational construction along lines of which we have absolute knowledge. "If this be treason, make the most of it."

M. N. FORNEY.

Just after last week's issue of Engineering News went to press, news reached us of the death of M. N. Forney, well known to engineers the world over as the author of the "Catechism of the Locomotive," one of the most successful technical books ever published.

Mr. Forney was entitled to high rank as one of the Nestors of American engineering journalism and the service he did to American railway development as editor for nearly 20 years of the "Railroad Gazette" and particularly in connection with the railway associations of Master Car Builders and Master Mechanics cannot be too highly spoken of.

A few years ago Mr. Forney prepared a brief autobiography and gave copies to a few intimate friends. He was the most modest of men, and never sought publicity for himself or his own achievements. He knew, however, from many years of editorial experience, how difficult is the task that so frequently besets the technical editor of setting forth in brief compass the life story of some noted engineer who has passed away.

While Mr. Forney doubtless intended his autobiographical notes to be used only as information from which writers might take such data as they chose, they are written in his own peculiar style and are of such interest that we have deemed it well worth while to print a large part of them as originally written.

Mr. Forney was born in Hanover, York Co., Pa., March 28, 1835. Two years later his father died leaving the mother with a family of three sons and three daughters to rear and educate. At 14 years of age Mr. Forney was sent to a school in Baltimore which he attended for three winters and this completed his school education.

In April, 1852, at the age of 17, he entered the shops of Ross Winans, the famous Baltimore locomotive builder, as an apprentice and remained there four years, the last year in the drawing room. At this point we begin Mr. Forney's own account of his career:

> I then secured a position as draftsman in the shops of the Baltimore & Ohio Railroad, in Baltimore, then under the charge of Mr. Henry Tyson, who was Master of Machinery of the road, and continued in that position altogether about three years. As the prospect of advancement there seemed very poor, in 1857 or 1858 I was led to go into mercantile business in Baltimore, and continued in such occupation for about three years more. This brought me to 1861, the period of the outbreak of the War of Secession.
>
> My business ventures up to this time had not been successful. All business in Baltimore was much disturbed, and after trying a number of different occupations I accepted a position as draftsman in the Machinery Department of the Illinois Central Railroad in Chicago, then under the charge of Mr. Samuel J. Hayes, who was Superintendent of Machinery of that road.
>
> While employed there I designed an "improved tank locomotive," which afterwards became known as the "Forney engine." A patent was applied for, but there was considerable difficulty and delay in the Patent Office before the patent was allowed, so that it was not issued until 1866. Although every effort was made to introduce it into use, my efforts had little success until it was adopted for the New York Elevated Railroads nearly ten years after the patent was allowed. No other kind of locomotive was ever used on those roads there-

after, and it was also exclusively adopted in the Brooklyn and Chicago Elevated lines, and many were also built for other roads. Now, 1903, these engines have been superseded in the elevated roads by electric power, but it is still a popular form of locomotive for suburban and some other kinds of traffic. After the patent expired it was very generally adopted. It was a source of some profit to me during the latter part of the existence of the patent, but never paid as much as it would if the merits of the invention had been recognized earlier.

My engagement on the Illinois Central R. R. also continued for about three years. After this a brief engagement as draftsman with the Detroit Bridge & Iron Works followed, which was succeeded in the spring of 1865 by an appointment by the President of the Illinois Central R. R. Co., to superintend the building of some locomotives for that line, for the construction of which a contract had been made with the Hinckley & Williams Works in Boston. This was in the spring of 1865, and occupied me for about six months. When the engines were completed Mr. Williams made an arrangement with me to remain in their employ. My duties were partly those of a draftsman and partly of a traveling agent. My services there also lasted about three years.

During the last year of that term, my office and headquarters were in New York, and when my engagement with that company was ended, and after a year or more spent in futile attempts to make a living by office and other work, in the fall of 1870 I accepted the position of Associate Editor of the "Railroad Gazette," which was offered to me by Mr. A. N. Kellogg, who then published that paper in Chicago. In 1871 the great fire occurred there and the publication office of the paper was temporarily—as it was then thought—removed to New York. Soon thereafter Mr. S. W. Dunning, who was Editor-in-Chief, and myself, each bought an interest in the paper, and a year or two thereafter bought the whole of it, each of us owning a half. In editing the paper, my department was that of engineering and mechanical matters, while Mr. Dunning had charge of the transportation and traffic department and general railroad news.

In 1873 we obtained a copy of Georg Kosak's excellent little book on the locomotive, written in German. Mr. Dunning, who read that language, agreed to translate the book and proposed that I should revise and adapt it to American practice, and that the translation should then be published serially in the "Railroad Gazette" and in book form thereafter. The translation was made and submitted to me for revision and adaptation, according to the original intention. Before that I had planned and had commenced writing an elementary treatise on the locomotive. In revising the first chapter of the translation of Mr. Kosak's book, it was found that it occupied, only to a very limited extent, the ground which in my incomplete plan I hoped to cover. Therefore the original intention of "adapting" Mr. Kosak's work was abandoned, and the whole book was rewritten and published in book form thereafter. In writing it, the aim was to explain the principles, construction and operation of locomotives in the simplest and clearest language possible, so as to be easily comprehended by engineers, mechanics, firemen and apprentices who have had few educational advantages. The only mathematics employed, excepting simple arithmetic, was one algebraic formula, and that might have been omitted.

The book seemed to supply a need, and at once had a large sale, which has continued ever since. It was rewritten and enlarged in 1889, and the demand for the revised edition still continues.

In 1872 I became an associate member of the American Railway Master Mechanics' Association, and in 1873 of the Master Car Builders' Association. About the same time—or perhaps earlier—I was elected a member of the American Society of Civil Engineers, but resigned a few years ago. I was one of the organizers, and am still (1903) a member of the American Society of Mechanical Engineers.

The work of these associations, especially the two devoted exclusively to railroad engineering, was of great interest to me, and for years I took an active part in their proceedings, as is shown in their early annual reports.

Away back in the 70's before any system of transit, more rapid than horse cars, existed in New York, its population and daily papers, every winter, were thrown into paroxysms by each severe snowstorm which obstructed traffic in the streets and made it very difficult for people to be transported up and down town mornings and evenings. During such periods all kinds of wild projects were proposed for systems of rapid transit above, below, and in the streets of the city. In September, 1874, during such a period of exacerbation, at my suggestion, Mr. Octave Chanute, then Chief Engineer of the Erie Railroad, introduced a resolution at one of the meetings of the American Society of Civil Engineers:

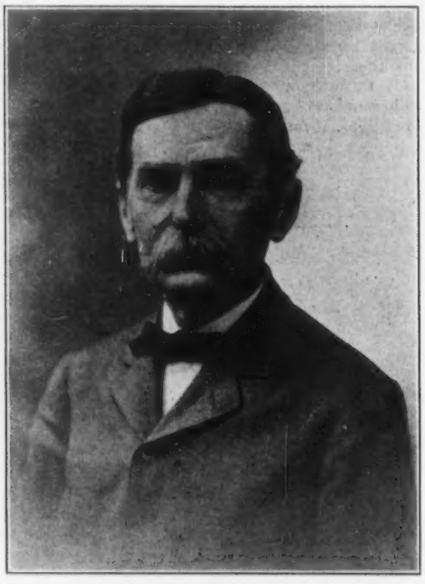
> That a committee of five members of the society be appointed by the president to investigate the necessary conditions of success, and to recommend plans for:
>
> First—The best means of rapid transit for passengers, and
>
> Second—The best and cheapest methods of delivering, storing and distributing goods and freight in and about the city of New York . . . and to report thereon.

The resolution was adopted, and a committee consisting of Mr. Chanute, Ashbel Welch, Gen. Charles K. Graham, Francis Collingwood and myself were appointed.

Although there were three other members of the committee, Mr. Chanute and myself did most of the work of preparing the report. We each of us devoted a great deal of time to collecting and tabulating data relating to the subjects submitted to the committee for investigation, concerning which there had then been very little reliable information published. The old Greenwich St. elevated railroad had been built from the Battery up to 30th St., on Ninth Ave., and had then abandoned the use of a cable, which was first used by Mr. C. T. Harvey for transmitting the motive power to the cars, and a small four-wheeled locomotive had been substituted for the cable. This was then the only thing approximating to "rapid transit" in the City of New York. The only data obtainable concerning the probable traffic and expenses of a real "rapid transit" road was from this line, and those operated on the surface of the streets; the motive power of all of the latter was then horses.

In the report made it was said:

> The committee deemed it necessary, as a preliminary basis, to ascertain what would be the probable earnings and expenses of rapid transit roads, and in what amount of capital the net revenue thus estimated would pay a fair rate of interest. The usual methods of assuming



M. N. Forney

> the operating expenses to be a certain percentage of the earnings seemed to us quite worthless when applied to roads possessing so many features of novelty. During the progress of this inquiry, therefore, two of the members of the committee made careful estimates, from the best data they could obtain, of the possible revenues, and of the cost of running trains furnishing the required accommodations. These computations were entirely independent of each other. . . . The result was gratifying. Although carried by somewhat different processes, the final computations agreed so closely as to give the committee confidence in the approximate correctness of their estimates.
>
> The conclusion which was reached was:
>
> That the traffic on rapid transit roads would in a few years be equal to 35,000,000 passengers per annum, on each side of the island, and that it would warrant an expenditure of about $935,000 per mile of road.

The last (1902) annual report of the Manhattan Elevated and the Interborough lines shows that 246,587,022 passengers were carried in the year covered by the report. When our committee in 1875 ventured to estimate that "the traffic on rapid transit roads would, in a few years, be equal to 35,000,000 passengers per annum, on each side of the island," or a total of 70,000,000, this "estimate" of the committee was regarded as wild and visionary.

The report was completed and read at a meeting of the Society held on Feb. 3, 1875. It was received with a perfect storm of opposition and denunciation by members, some of whom had for years been recommending and lending their names and influence to different schemes for rapid transit railroads. The report was, however, printed by the Society. Legislation was then pending in Albany, which led to the appointment of what was known as the "Tilden committee," whose investigations and report was followed by the enactment of a Rapid Transit Act under which the existing elevated roads were built. The report was placed in the hands of that committee and had much influence in shaping legislation and guiding those who directed it. The value of the work which the committee did, however, was never recognized, although it served to shape legislation and guide those who afterward built the elevated roads and resulted in great advantage to their projectors and the public generally.

The appendix which I wrote for the report contained the recommendation, "that no authority should be granted to any company to build a rapid transit railroad without the express stipulation that not more than half-fare should be collected unless the passenger is provided with a seat on demand." My recollection is that such a just and salutary provision was inserted in the original bill, but was eliminated before it finally passed the legislature.

After being a member of the Master Car Builders' Association for a number of years and taking an active part in its work, it became apparent to me that there was a great deal of work which such an association ought to do, but which could not be done unless some direct relations existed between it and the railroad companies, whose interest it should represent. At the same time, it was evident that any important change in the existing conditions of membership would be defeated if proposed to the association. In this dilemma, to quote from a report made in 1889, "the idea was conceived of leaving the conditions of membership the same as theretofore, but of creating a new class of members to be appointed by the Presidents, General Managers or General Superintendents, to represent the railroad companies in the association, such members to have a vote proportionate to the number of cars owned by the companies they represented. This measure was proposed to some of the older members, including Leander Garey, F. D. Adams, and others, and approved by them.

After much negotiating, many reports and a great deal of discussion, such a measure was finally carried and ultimately resulted in all the principal railroad companies in this country and Canada appointing what were called representative members.

It was carried, however, in the face of very strong opposition, but its salutary effect upon the association and its effectiveness at once became apparent, and the beneficial results have increased every year since.

A full account of the reorganization of the association was given in my final report to the association as secretary in 1889. In that it was said: "The influence of the association has been very much widened and strengthened by the reorganization, which has given to railroad companies a representation in its deliberations."

After the reorganization in 1882, I was appointed secretary of the association and held that position until 1889. The work interested me very much, and perhaps by aiding in the adoption of standard forms and methods of construction of cars, and the introduction of safety appliances, some good may have been accomplished. At any rate, the work which was commenced then has been followed up by other people and other agencies—notably the Interstate Commerce Commission—so that there is the satisfaction of having helped in a movement which has greatly lessened the loss of life and limb in railroads.

Early in the history of the Master Car Builders' Association the confusion of names used to designate the different parts of cars attracted attention, and in 1871 a committee was appointed to prepare a "Dictionary of Terms used in Car Building."

In the preface of the "Dictionary" which was subsequently published, it is said:

> This committee originally consisted of eight or ten members, who held a number of meetings without accomplishing much, and it soon became apparent that it was too unwieldy to do the work which had been undertaken.
>
> It was finally narrowed down to Leander Garey, Calvin Smith and myself. I did the writing and the other members acted as consulting members of the committee. We held many meetings, and the preparation of the first edition of that book was a long and tedious work. The book was, however, finally completed, and published by the "Railroad Gazette." Several new editions have been issued since.

Mr. Dunning and myself continued to publish the "Railroad Gazette" until the end of 1883. I then sold my interest to W. H. Boardman, who had been business manager of the paper for a number of years. In a valedictory editorial, with the title "Some Last Words," published in the "Railroad Gazette" of Dec. 28, 1883, it was said:

> The work of editing a journal like the "Railroad Gazette" is not only severe, but unremitting. Every week brings its tasks, and there is no opportunity for recuperating exhausted energies, however serious the need may be. . . . When it became apparent that the editorial steam gage could no longer be kept up to working pressure, the question had to be decided whether it would be wisest under the circumstances to diminish the loads and continue at work until the mechanism was fit only for the scrap heap, or whether it would be best to uncouple from the train entirely and lay up for thorough repairs. The latter plan is the wisest course to pursue with locomotives, and is the one which the master mechanic who superintends the repairs to the writer insisted must be adopted in his case, or the machine would soon be too dilapidated for any further service.

And thus a career commenced with much hope, pursued with more or less a little toil, is ended with some disappointed ambitions, but with many pleasant and some tender recollections.

For three years thereafter—my life seems to have been divided into cycles of three years—I was not engaged in any regular business. Doing nothing soon grew wearisome, and in the latter part of 1886, for the sake of having a regular occupation, I bought the "American Railroad Journal" and Van Nostrand's "Engineering Magazine," and on the first of January consolidated the two publications under the name of "The Railroad and Engineering Journal." That paper I published and edited until the end of 1895, but changed its name at the beginning of the year 1893 to the "American Engineer and Railroad Journal." The enterprise, however, never was financially successful, and on Jan. 1, 1896, my interest in it was sold to R. M. Van Arsdale, the proprietor of "The National Car and Locomotive Builder," who then consolidated the two publications. Part of the agreement in making the sale was that I should edit the new paper for one year.

Since that time I have not been in any regular business, although much occupied in different ways and on a variety of matters.

Invention has always had a great fascination to me as it has many others. It is akin to the passion which the fortuity of gambling has to a gamester, and once having developed the taste for invention its allurements have led me on, as will be shown by the following list of patents which have been granted to me, and which will indicate the subjects in which my efforts to improve things have been exercised:

No.	Date.	Title.
52,466	Feb. 6, 1866.	Locomotives.
247,034	Sept. 13, 1881.	Interlocking switch and signal apparatus.
250,517	Dec. 6, 1881.	Railroad signaling apparatus.
266,802	Oct. 31, 1882.	Railway tell-tale.
266,985	Oct. 31, 1882.	Locomotive engine.
17,949	Oct. 24, 1883.	Improvement on locomotive engine (Canadian).
324,825	Aug. 25, 1885.	Car seat.
354,631	Dec. 21, 1886.	Furnace doors.
360,148	Mar. 29, 1887.	Car seat.
408,004	July 30, 1889.	Locomotive engines.
414,035	Oct. 29, 1889.	Railroad car bodies.
436,055	Sept. 9, 1890.	Safe depositories for railroad cars.
472,059	Apr. 5, 1892.	Fire grates.
482,447	Sept. 13, 1892.	Reversible backs for car or other seats.
485,344	Nov. 1, 1892.	Locomotive engine.
488,902	Jan. 3, 1893.	Reversible backs for car or other seats.
489,648	Jan. 10, 1893.	Counterbalance and guides, reciprocating mechanism.
510,636	Dec. 12, 1893.	Steam boilers.
518,209	Apr. 17, 1894.	Steam boilers.
527,842	Oct. 23, 1894.	Car seats.
527,900	Oct. 23, 1894.	Locomotive axle boxes.
528,294	Oct. 30, 1894.	Means for counterbalancing momentum of reciprocating mechanism.
20,908	Oct. 30, 1894.	Improvement in steam engines (English).
557,794	Apr. 7, 1896.	Valve gear.
566,075	Aug. 25, 1896.	Car seats.
632,708	Sept. 12, 1899.	Feed water heaters for steam boilers.
671,620	Nov. 13, 1900.	Multiple address envelope.
688,402	Dec. 10, 1901.	Feed water and steam heaters for steam boilers.
701,477	June 3, 1902.	Means for counterbalancing the momentum of reciprocating elements.
735,739	Aug. 11, 1903.	Fluid pressure engine.
735,740	Aug. 11, 1903.	Fluid pressure engine.
735,741	Aug. 11, 1903.	Fluid pressure engine.
735,742	Aug. 11, 1903.	Fluid pressure engine.

Of the patents on tank locomotives mention has already been made. Thus far the only other of these patents which have been profitable to me are some of those on car-seats. These for a time yielded me considerable income. Some of the rest, I feel sure, would have done so if sufficient effort had been made to introduce them, or, in other words, if they had been properly "pushed" commercially. Of the ultimate success of those, which still have any considerable term of existence, it is, of course, impossible to predict. It may, however, be well to make a confession here of a consciousness of a deficiency of the kind of capacity needed in selling things, and a constitutional abhorrence of anything relating to what is called the "solicitation of business." Probably if as much effort had been exerted, to the introduction of some of my inventions as was exercised in devising and perfecting their mechanical features, they would have been more or less successful and perhaps profitable. The mechanical development of my various schemes has been intensely interesting to me, whereas, the effort required to introduce them has always been more or less obnoxious.

Besides a disposition to improve mechanism of various kinds, I have also had an inclination to improve social and political affairs, and to that end, have been a member of the American Free Trade League and American Peace Society in Boston, the Citizens' Union and Anti-Imperialist League of New York, and have been a member of the Executive Committee of the latter. I am also a member of the Union League, the Century, the Engineers' and the New York Railroad Clubs. In 1898, the American Railway Master Mechanics' Association did me the honor to elect me an "honorary member." My associate membership dated back to 1872, and that in the Master Car Builders' Association to 1873. The latter elected me a life member in 1890.

Besides the two mechanical books already referred to, in 1894, when the Constitutional Convention of the State of New York was in session, I wrote a book with the title "Political Reform by the Representation of Minorities," with the purpose of influencing that convention to make some form of Proportional Representation possible in this state. It failed to accomplish that purpose, and apparently has had little or no other influence. Later I wrote and published two pamphlets, one with the title "Proportional Representation; A Means for the Improvement of Municipal Government," and the other, "Minority Representation in Municipal Government." If any of these ever produced any effect it has not yet been made apparent to me. Writing them, however, gave me some diversion, and it, of course, may be that it is a case of "bread cast upon the waters." I have had and still have a strong conviction that the most effective means of improving national, state and municipal government, would be some form of proportional or minority representation, which would place it in the power of portions of people, less than a majority, to represent their views and interests. The justice of such a measure does not seem to be suited to the apprehension of popular intelligence, or perhaps it should be said, popular ignorance.

Mr. Forney's recital of his life experience places too little emphasis on his work as technical editor of the "Railroad Gazette," in the years from 1873 to 1884. At that period technical journalism was in its infancy. The clientele of technically trained engineers who are now the chief supporters of engineering journals was not yet created. The railway officers who had been educated in the school of hard knocks had an inherent distrust of book knowledge on technical subjects. The character of the technical journals of that day was not, indeed, such as to inspire confidence.

Mr. Forney, as may be gathered from his recital above, had little to aid him in the way of school training, and his experience had been chiefly in subordinate positions on unimportant work. Yet by industry and inherent ability, he made his journal a commanding influence in the railway field.

Nothing in Mr. Forney's life better illustrates his sound engineering common sense than his opposition to the narrow-gage fallacy that swept over the country in the '70's and caused so many million dollars to be spent in unwise schemes. So far as we are able to find, all the other technical journals of any account, both in this country and in England, succumbed to the narrow-gage craze and lent their editorial columns to its advocacy. It was characteristic of Forney that notwithstanding the weight of authorities on the other side, he stood firm for his conviction and in season and out of season condemned the narrow-gage fallacy. That this young man of 35, with no engineering education outside of that wrought out in the locomotive shop and drafting room, should have had the engineering prescience to judge clearly when others of high authority were misled speaks volumes for his ability and sound judgment as an engineer.

Great emphasis should be laid on his work in reorganizing the Master Car Builders' Association and transforming it from a mere voluntary society of railway officers into an official body with the legal authority to control and regulate for the general good the important matter of freight car interchange. The value of this service to the public far transcends its value to the railway corporations themselves.

This article would be incomplete without mention of Mr. Forney's remarkable personal qualities. He was the soul of honor, honesty and candor, prompt to take whichever side of a controversy he deemed to be right and hold it with unwavering constancy; yet his treatment of opponents was so devoid of all personality or bitterness, that even those whom he criticized never bore him malice. If he had an enemy in the world, we never heard of it.

Some trivial eccentricities of habit and thought and bluntness of speech may have made his intimate friends fewer, but none who knew him gave him less than respect, and those who knew him well, honored his blameless and unselfish life.

His early years of struggle and toil for a livelihood were ended when his success with the "Railroad Gazette" gave him a competence for all his needs; but he would have lived a plain and simple life just the same had he won a fortune of millions.

After his early years of struggle, he worked not for money or for ease or for fame or the hope of reward; but with the sincere desire to benefit his fellowmen. If some of his ideas be accounted Quixotic, they yet display his unselfish zeal for service.

A man of quiet and domestic tastes, he yet lived a bachelor nearly all his days, as he himself frankly confessed, because in his youthful and impressionable years, his means were too limited to permit marriage. Less than a year ago, however, at the age of 72, he was married to a friend of earlier years.

ANNUAL MEETING OF THE NEW ENGLAND WATER-WORKS ASSOCIATION.

The annual meeting of the association was held at Boston on Jan. 8, 1908. In his presidential address, Mr. John C. Whitney, Water Commissioner of Newton, stated that the membership of the association had had a net growth of 18 during the year, making a total of 702 members at the present time. Even with this membership more than 40% of the New England towns with a population of 3,000 or more are not represented in the association, although a number of cities, towns and water companies have adopted the commendable practice of paying the membership fees of their superintendents, and also the expense of attending the meetings of the association. The secretary, Mr. Willard Kent, M. Am. Soc. C. E., presented his annual report showing in detail, the changes of membership, the receipts and the principal expenditures of the association. The treasurer, Mr. Lewis M. Bancroft, reported total receipts, including interest on deposits, of $5,292, and expenditures of $4,222, with a cash balance on hand of $1,480. The Editor of the Journal, Mr. Charles W. Sherman, M. Am. Soc. C. E., reported a total expenditure for the year, on account of the Journal, $2,643, and the receipts from advertising, subscriptions, sales, etc., $2,160, leaving $483 as the net cost to the association to be paid from members' dues, making a net cost per member for the year of 70 cts. The four quarterly numbers of the Journal included a total of 66 pages, of which 509 were text and the remainder indexes, advertisements, etc.

Mr. Dexter Brackett, M. Am. Soc. C. E., Chief Engineer of the Metropolitan Water-Works, who is chairman of the association's committee on specifications for cast-iron pipe, presented an informal progress report, discussing briefly the specifications presented to the American Water-Works Association at its convention of 1907, and the correspondence between the committees of the two associations which had preceded the presentation of those specifications. He stated that he did not think that the American Association had yet reached a specification which was any improvement over that of the New England Association, or that there is yet any reason for modifying the New England specifications.

A canvass of the letter ballots showed that there had been elected as President, Mr. Alfred E. Martin, Superintendent of Water-Works, Springfield, Mass., and that Messrs. Kent, Bancroft and Sherman had been re-elected as secretary, treasurer and editor, respectively, and Mr. Robert J. Thomas, Lowell, Mass., as advertising agent.

The first paper of the afternoon was by Mr. Harry L. Thomas, Assistant Superintendent of the Hingham (Mass.) Water Co., entitled "Experience with a Producer Gas Plant." This paper discussed in considerable detail one year's experience in operating a 1,500,000-gal. pumping plant, consisting of suction gas producer and gas engine operating a triplex pump. Many of the experiences were trying and some were ludicrous, as might naturally be expected from the operation of a plant of this kind by engineers previously accustomed to steam boilers and engines. The results, however, have been eminently satisfactory, and the economy in expense very con-

siderable. The paper was a very interesting one and was admirably presented, arousing considerable discussion, especially from Messrs. E. H. Gowing, S. H. McKenzie and Frank A. Barbour. Mr. Barbour spoke of a very similar plant built by him last year at St. Stephens, N. B., where substantially similar results were obtained, and said that for a plant of that size he should certainly favor a producer gas system.

Mr. F. F. Forbes, Superintendent of the Brookline (Mass.) Water-Works, read a short paper entitled "One Year's Experience with an Automobile for Business by a Water-Works Man." Mr. Forbes detailed briefly the misgivings of the local authorities before deciding to purchase an automobile for the use of the superintendent. He summed up the results of its use as a great increase in efficiency of the superintendent, equivalent in general to a material increase in the length of his working day. The machine was a runabout, and cost, equipped and ready for service, about $800. The actual maintenance cost for the year had been about $275. Allowing for overhauling once a year, and that depreciation would be such that the machine would be discarded at the end of four years, he figured the total cost per year at about $575 or $1.56 per day. Several other superintendents, speaking in discussion, recited substantially similar experiences. Mr. Dexter Brackett, Chief Engineer of the Metropolitan Water-Works, said that those works were now using three automobiles, and that in his opinion the saving in time was the principal advantage from their use; at least in one case, the automobile was practically worn out at the end of three years. Mr. William F. Sullivan, of Nashua, N. H., gave some figures on the operating cost in his case; actual maintenance cost being $51.19 for 2,300 miles.

Mr. Freeland Howe, Jr., a chemist and biologist, of Norway, Me., read a paper on "Action of Water on Water Pipes." He detailed in a semi-technical way the chemical conditions in which metal is taken into solution in water, in accordance with modern chemical ideas. Many of the members, apparently, found the chemical discussion too technical, but a considerable number followed the paper with much interest, and several took part in the discussion.

DEPRECIATION ALLOWANCES FOR VARIOUS PUBLIC-SERVICE INDUSTRIES.

We reproduce herewith, as Table I., a compilation of depreciation allowances for various public-service industries, included in a paper by Mr. Wm. H. Bryan, read before the Engineers' Club of St. Louis, Nov. 6, 1907.* The paper was entitled "The Appraisal and Depreciation of Water-Works and Similar Properties." The text related almost wholly to water-works, but many of the ideas advanced by the author are equally applicable to gas works, electric lighting plants, street railways or any public utility being valued for purchase, rate fixing or taxation. Table II. shows the prices for cast-iron pipe of various sizes paid by the city of St. Louis, Mo., for about twenty years past.

In our issue of Nov. 2, 1905, there appeared an editorial on "Municipal Loan Purposes and Periods in England and the United States," in the course of which there was included a "List of the principal objects for which the Local Government Board [England] sanctions loans, with the periods *usually* allowed for repayment." The list included some forty objects, from baths to weighing machines, with numerous subdivisions under gas and electric lighting, water-works, etc. The periods ranged from 2 years for gas retorts to 60 and 80 years for land, and are of interest and value in connection with the subject of depreciation.

BIDS FOR A DIRIGIBLE BALLOON for the Army Signal Corps were opened at the War Department on Jan. 15. Specifications were issued several weeks ago and six proposals were received. It is stated that the bidders, price and time necessary for construction were as follows: (1) Carl E. Myers, Frankfort, N. Y., $9,996, 120 days; Wm. Reiferscheid, Streator, Ill., $5,000, 150 days; Chas. J. Strobel, Toledo, Ohio, $8,000, 120 days; H. B. Schiller, Philadelphia, Pa., $25,000, 120 days; John Kalries, Mt. Vernon, N. Y., $10,000 to $30,000, according to speed; E. W. Creacy, Washington, D. C., $12,500, 90 days. The Curtis Manufacturing Company, Hammond Court, N. Y., telegraphed that a bid had been mailed. These proposals were examined by a board of award composed of officers of the Signal Corps, and it is reported that all were rejected because of insufficient specifications. A balloon will be finally accepted after a trial flight which, it is expected, will be made at Fort Myer, Va. These proposals should not be confused with the proposals for a "heavier-than-air" flying machine, specifications for which appeared in Engineering News, Jan. 2.

*Jour. Assoc. Eng. Soc., December, 1907; Fred. Brooks, Secretary, 31 Milk St., Boston, Mass.; 30 cts.

TABLE I.—SHOWING ESTIMATED LIFE AND DEPRECIATION OF APPARATUS, MACHINERY, ETC., COMPILED FROM VARIOUS SOURCES BY WILLIAM H. BRYAN, M. E., ST. LOUIS.

Material.	Life in Years.	Depreciation per cent. per yr. Straight.	Depreciation per cent. per yr. Sinking Fund.	Authority.	Remarks.
Entire Systems:					
Electric Light	20			4	Am. Inst. E. E.'s.
"	12.33	8	3	4	N. Y. Edison Co.
"				4	English municipal Engineers.
"		8		4	Mass. Gas & El. Com.
"		7.5–10		4	Motions made but not adopted.
"	12.5, 14			5	
"	10.05, 20			6	
		6.4–7.4			
Water Works		4.465		1	Los Angeles, Cal., 19.3% in 20 yr.
"		2.667		2	Kansas City, Mo., 33.3% in 30 yr.
"		1.1		3	Tuttle.
"		.02		E. R., 7-23-'04	Quincy, Ill., 18.7 % in 30 yr.
"		0.47		M. E., May, '03	Valparaiso, Ind., 37.1% in 25 yr.
"		.86	1.58	E. N., 4-23-'03	Mobile, Ala.,
"	37.35	1.95	1.49	6	20 % in 14 yr. Washington, Mo., 33.3% in 19 yr.
"	40		1	C. Palmer.	
"				E. R., 6-1-'01	Court Centre, Costa, Cal.
"	37		1.50	2	P. C. Coffin.
"	31		2	3	Haverhill, Mass.
"		1.99		6	Rich Hill, Mo.
"		2.31		6	Galena, Kan.
"		2.01		6	Mt. Carmel, Ill.
Water, Gas and Elec. Light Plants (Average of 52)		2.784		E. N., 5-7-'03	19th An. Rep. U. S. Com. of Labor.
Arc Lamps	8			5	
Belts	12–25			6	
"	3–4			7	
Boilers	6–25. Av. 15	5–7		8	Average of 52.
"	15			9	
"	20–30			10	
"	30			7	
"	30–12.5			3	
"	16–15			11	
"	25			12	
"	30	8		13	
"	14.3–25			6	
"		2.5–4		14	
"		6		15	
"	25			17	
Bonding, Track	10–16	3		13	
" "				7	
Bridges					
Iron		1		9	
Masonry		1		9	
Trestle		15–20		9	
Buildings					
Brick		2		5	
"		2		9	
"	40			13	
"	25–40			6	
"		7		14	
"	60			10	
"	50–100			7	
"	25–33–50			5	
"	30			11	
"	30			12	
"		5		13	
"		3.5		16	
"	35			17	
Wooden		5		9	
"		4		14	
"	15–20				
Cables, Feeder	20–35			7	
Cars	28–25			7	
" Bodies		7		13	
" Motors	10.5–20			7	
" Trucks		8		13	
Condensers		7–10		9	
"	10.5			5	
Conduits		3–5		9	
Converters					
Stationary	25			10	
"	15–20			7	
"	12.5			8	
"	10–12.5			6	
Rotary	10–12.5			7	
Engines					
Steam		4–6		9	
"	25			10	
"	15–25			7	
"		5		13	
"	20	5		6	
Pumping	20–25–30	5		6	
"		3–10		9	
"	25			13	
"	20–30			3	
"		4.7		14	
"	25			10	
"	10			5	Boiler feeds, etc. Average of 30.
" "	3–26. Av. 21.3			8	
"	25–30			11	
"	30			15	
"		2.5		16	
"	30			17	
Engines & Generators					
Belted	20–30			7	
Direct connected	12.5–25			7	
Filters, Water	25–30			6	
Gear Cases		20		13	
Generators	25			6	
"		7–12		9	
"	25			10	
"	10–20			7	
"		3		13	
Hydrants, Fire	25–35			6	
" "		3		7	
" "	40			11	
Insulators					
Pole Line		20		13	
Trolley		7		13	
Meters					
Electric	10			10	
"	20			5	
"	10–12.5			7	
"	20			6	
Water		3		1	
"		2.1		E. N., 4-23-'03	Mobile, Ala.
"	20			3	
"	20			6	
Motors					
Car	12.5–20			9	
Armatures		33		13	
Commutators		33		13	
Controllers		4		13	
Fields		10		13	
Paving,					
Asphalt		7		13	
Brick		7		13	
Cedar Blocks		10		13	
Granite		5		13	
Macadam		6		13	

Material.	Life in Years.	Depreciation per cent. per yr. Straight.	Depreciation per cent. per yr. Sinking Fund.	Authority.	Remarks.
Pipe					
Cast Iron	50–75			6	
"	60			E. R., 8-28-	
"		1.25		1	
"		0		5	
"	50–60			3	
"	25–60			5	
"	70			15	
"	Over 50			3	
"		1.14		14	
"		1		15	
"	100			8	
"	100			17	
"	80			11	
"	75			12	
Service	20			6	
"		2.5		6	
Wrought Iron		5		15	
"	30			15	
"	20			15	
"	15–20			5	
In Plant		3		17	
"	25			11	
"	25			12	
"	14–25			5	
"	20–30			6	
"		20		16	
Pole Line	15			6	
"		12–15		9	
Poles					
Iron		4		13	
Wooden		4		13	
& Cross Arms	10–12.5			5	
Rails		2.5		13	
Reservoirs	50–75			5	
"	40–75			6	
"	100			17	
Standpipes	25–30			6	
"		4		14	
"	40			15	
"	30			19	
Storage Batteries	9–11			7	
Switch Boards	20			5	
Ties		7		13	
Track		8–12		9	
"	7–15			7	
Trolley Line	12.5–25			7	
"		5		13	
Turbines, Water	12–24			7	
Valves	25–35			6	
"	40			11	
Wire, On Poles	40			5	
Wiring of Cars		8		13	

TABLE II.—SHOWING PRICES PAID BY THE CITY OF ST. LOUIS FOR CAST-IRON PIPE DELIVERED AT YARDS IN ST. LOUIS SINCE 1889, PER TON OF 2,000 LBS.

Date of Order.	Sizes in Inches, and Quantities in Tons. 3	4	6	8	10	12	15	20	30	36	42	48	Price.
1889	38												$16.45
2-19-'90			330	75		395							18.15
4-2-'91						390							17.84
1-28-'91			325			335							17.71
8-9-'91			1 400	130		910	6						19.75
2-10-'92			35			35		1 000	210				23.47
4-25-'92						720				50			21.45
7-30-'92			1 440	40		720							21.45
10-12-'92						5				60			21.45
2-18-'93	30	30	1 400			1 560		2 035	420				24.45
8-21-'94			810			810	30	1 780	1 350	1			23.54
4-1-'95									3 300				23.54
5-23-'95		8	787			55							23.05
10-25-'95								950	5 400				23.47
2-8-'96	85	75	1 550	25		1 200							24.00
8-12-'96			900			1 450		350					23.74
10-12-'96						1		155	2 015	6			24.00
6-10-'97			750		6	2 400		1 044					24.17
7-12-'97													23.21
9-29-'97				30		70	50	1 200	100				23.74
3-31-'98			375			1 500	25	1 085					24.00
7-23-'98			600			1 320		1 401					24.00
2-20-'99			650			2 700		250	400				23.84
6-10-'99			600			1 075		1 590		1 300			24.00
4-21-'00			1 000			2 000		1 050					24.00
8-14-'00			10			28							23.74
5-4-'01			700			1 600		1 210	820				23.93
5-8-'02			1 141			2 975		1 345	2 720				23.93
5-1-'02			820	175	223	550							23.93
2-20-'03	25												23.93
7-30-'03		15	1 390			1 790	30	1 175	700				23.93
6-4-'04	70												23.93
8-4-'04		30	1 140			800		1 160	80	1 200			24.00
3-1-'05	15												24.45
7-1-'05			1 160										24.45
5-1-'05						1 360							24.45
8-1-'05								378	840	1			23.74
1-20-'06			2 200			2 650		1 050					23.93
9-15-'06			1 350										23.74
9-15-'05						700		1 050					23.93
1-17-'07	24												23.93
5-14-'07			1 430			1 075		1 460		1 100			23.93

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THE PRESIDENTS OF FOUR NATIONAL ENGINEERING SOCIETIES.

(With Inset Sheet of Portraits.)

We present to our readers this week, in accordance with our annual custom, portraits of the Presidents of the four great American engineering societies. It is perhaps noteworthy, as an indication of the extent to which engineering activity is attracted to the financial center of the nation at New York City, that three out of the four Presidents reside in New York or have their professional headquarters there, and the same thing was true of the four Presidents in office a year ago. It is, on the other hand, an indication of the broad field from which the American engineering profession draws its leaders that the Civil Engineers' President is a Canadian by birth, Mr. Holman, of the Mechanical Engineers, was born in Maine and transplanted to Missouri, Mr. Hammond is a Californian, and is known almost as well in South Africa and London as in his own country, and Mr. Stott is a Scotchman who practised his profession in Spain as well as in his native land before coming to the United States.

Brief biographies of each of these gentlemen follow:

Charles Macdonald: President of the American Society of Civil Engineers.

By ALFRED P. BOLLER,* M. Am. Soc. C. E.

At the annual meeting of the American Society of Civil Engineers, on Jan. 15, there was installed as its chosen President for the ensuing year Mr. Charles Macdonald, well known as one of the leading engineers of America.

Mr. Macdonald was born at Gananoque, Canada, in 1837, and the ambition of his youth early turned to the engineering profession for his life's work. At the time he was ready to leave school, the surveys for the Grand Trunk Ry. were under way, and the opportunity was afforded him to commence his career by an appointment on the engineer corps surveying the line between Kingston and Rockville, and he remained on that work until construction began in 1853.

The late Sir Samuel Keefer, who was then at the head of that survey advised young Macdonald that if he really wanted to become an engineer he should seek to fit himself by a thorough technical training. The only engineering school on the American Continent in those days was the Rensselaer Polytechnic Institute of Troy, which had under the far-seeing administration of Benjamin Franklin Green been elevated from a simple school of science to a broadly planned school of civil engineering, conducted on such basic principles as have kept it to this day in the van of all competitors. The course then, as now, was four years, which young Macdonald passed through, graduating as Civil Engineer in 1857.

Thus prepared, he returned to Canada, and secured an engagement on the extension of the Grand Trunk Ry. from Sarnia to Detroit. On the completion of that work the prospects for engineers in Canada were not at all promising, so Mr. Macdonald sought and obtained employment in the United States, upon the Reading Railroad, as an Assistant Engineer, in the spring of '63.

Hardly had he been installed in his new position when the "call to arms" came from the Pennsylvania authorities for every available citizen to defend the state against a threatened invasion of the Confederate forces under Gen. Lee, who had defeated the Army of the Potomac in Virginia, and with his victorious army was marching north. With a company of railroad men, Mr. Macdonald responded to the call, and they had the usual experience of raw, untrained recruits sent to the front. Some of them were captured at Gettysburg, among them Macdonald, who by rare good luck was set at liberty next day and started northward. After the battle of Gettysburg, the new fledged recruits were disbanded and sent home.

Mr. Macdonald resumed his relations with the Reading R. R., and was placed in charge of the Perkionen Branch R. R. On this branch quite an important bridge was required over the Schuylkill River, the construction of which was a turning point in Mr. Macdonald's life. From that time onward his life has been devoted to bridge building as a specialty.

On the completion of the above work, he formed a partnership with A. B. Burton, who had formerly been identified with the famous old-time firm of Stone, Quigly & Burton, who were the Howe Truss bridge builders of the Eastern Middle States, and who, by the way, built, over the Little Lehigh River, under Jno. W. Murphy, one of the first, if not the first, iron truss R. R. bridge in the States.

At this time, in 1866, the Morris & Essex Ry. was building its Boonton Branch, a low-grade division between Hoboken and Dover, N. J., and Macdonald & Burton received the contract for all the bridges on the line, many of which were large and important structures. Those were the days of wooden and composite bridges, but Mr. Macdonald's ambition led him to the study of iron bridge designing, and in 1872 he designed and received the contract for the Point bridge at Providence, a draw span of 250 ft., which was a marked advance in such structures.

The Delaware Bridge Co. was soon after organized with Mr. Macdonald as President, and the list of its accomplishments are many. Although without shop facilities of its own, this concern was a very successful one. It built the Pennsylvania R. R. bridge over the Susquehanna River at Harrisburg, and the double track bridge over the Passaic River for the Morris & Essex R. R. as well as all the bridges of the Hoboken terminal yards. One of the latter, a 200-ft. double track skew span is doing good service on the main line of the above road to this day.

In the early 80's bridge building was becoming an unprofitable business, through fierce competition, and in 1884 the Delaware Bridge Company gave way to the famous combination known all over the world as the Union Bridge Company. This organization was composed of Thomas Curtis Clarke from the Phoenix Bridge Co., Geo. S. Field and Edmund Hayes of the Central Bridge Works at Buffalo, C. S. Maurice and Chas. Kellogg of Kellogg & Maurice, Athens, Pa., and Charles Macdonald of the Delaware Bridge Co. All these men had made great reputations for their respective concerns, were active, aggressive, and experienced, and soon made the Union Bridge Co. the leading concern for building long span bridges in America. A great many notable works were built while the partnership lasted, including most of the bridges over the great Western rivers, and the Poughkeepsie bridge over the Hudson. Probably the company's greatest work was the Hawkesbury bridge in New South Wales, Australia, particularly interesting on account of the foundation difficulties met and overcome. This work was awarded the Union Bridge Co. in competition with the engineering firms of the whole world by a commission of engineers in London headed by the late Sir Benjamin Baker. Unexpected difficulties were met in sinking the foundation caissons with a consequent demoralization of the working force, which made it incumbent for one of the principal partners to proceed to Australia and straighten matters out. This responsibility fell upon Mr. Macdonald's shoulders, and on a half day's notice, in company with his wife, he started to the scene of the troubles. One year was spent by him in Australia, and the whole work was brought to a successful and profitable conclusion, but only after many an anxious day.

After a brilliant professional and business success, the Union Bridge Co. partnership was dissolved by the withdrawal of all partners save Mr. Macdonald, and he finally merged the business in the American Bridge Co. in 1900, which concern shortly afterwards became one of the constituent companies of the U. S. Steel Corporation.

Mr. Macdonald is a member of the Century Association, the American Institute of Mining Engineers and the Engineers' Club of New York City. He is a Trustee of the Rensselaer Polytechnic Institute of Troy.

Queens College of Kingston, Canada, has bestowed upon Mr. Macdonald the degree of LL. D. in token of his successful career, and the past fall his native town of Gananoque, to which he has returned to make his permanent home, honored him with a grand civic celebration and banquet, when he was presented with a casket containing a beautifully illuminated address of welcome and appreciation.

Much may be expected from Mr. Macdonald's administration of the affairs of the American Society of Civil Engineers the coming year, as he has always taken great interest in the Society. He was Chairman of the Committee of Publication in 1873, when the monthly issue of the "Transactions" was established, and system instituted in the printing and distribution of professional papers. With abundant leisure and high endeavor, the new President will give a devoted personal service to the Society, which can congratulate itself upon the fortunate choice made by the Committee on Nominations.

*Consulting Engineer, 1 Nassau St., New York City.

Minard Lafevre Holman: President of the American Society of Mechanical Engineers.

By WILLIAM H. BRYAN,* M. Am. Soc. M. E.

Minard Lafevre Holman, the first President of the American Society of Mechanical Engineers elected from west of the Mississippi River, was born June 15, 1852, in Mexico, Maine, of which state his parents were natives. His paternal grandfather was Abner Holman, of Maine, whose father was one of the "Minute Men" of the Revolution. In 1859 Mr. Holman's parents removed to St. Louis, and the father soon enlisted in the Civil War and died some years later from wounds which he received.

Mr. Holman's early education was in the public schools of St. Louis. From these he entered the Engineering Department of Washington University, and was graduated in 1874 with the degree of Civil Engineer. He received from his Alma Mater in 1905 the honorary degree of Master of Arts, and has been President of the Alumni Association of the University.

His first engagement after graduation was in the Supervising Architect's office of the United States Treasury, at Washington, D. C., where he remained two years. After leaving Washington he spent some time in Tennessee, and on returning to St. Louis entered the engineering offices of Messrs. Flad & Smith. This firm consisted of the late Col. Henry Flad, who was President of the American Society of Civil Engineers in 1886, and the late Prof. Charles A. Smith, then Professor of Civil and Mechanical Engineering at Washington University, under whose instruction Mr. Holman had carried on his studies for several years. The close contact with these able men, and the experience gained on the important works, then in their charge, were undoubtedly influential in shaping his future career.

In October, 1877, Mr. Holman entered the Water Department of the city of St. Louis as a draftsman, advancing rapidly until he reached the position of Principal Assistant ten years later. He resigned this office to accept the appointment of Chief Engineer of the Missouri Street Railway Co., which was preparing to change its extensive systems of street car lines from horse to cable traction. He had just entered upon this work when the then Mayor of St. Louis, Hon. David R. Francis (who has since been Governor of the State, Secretary of the Interior and President of the Louisiana Purchase Exposition) asked him to accept the office of Water Commissioner, in charge of the entire water system of the city.

The existing water-works were antiquated, and had fallen behind the needs of the city. Furthermore, the source of supply was becoming more and more polluted through the growth of the city north of the Bissell's Point intake. It was imperative, therefore, that plans be undertaken at once for the extension and modernization of the plant. Mayor Francis assured Mr. Holman that he would have the hearty backing and cooperation of the city administration in his efforts.

*Consulting Mechanical and Electrical Engineer, St. Louis, Mo. Past-President Engineers' Club of St. Louis.

Mr. Holman accepted the appointment, and remained in that office twelve years, until 1899. During his incumbency a new low service pumping plant was constructed at the Chain of Rocks, an excellent location seven miles north of the city and four miles below the mouth of the Missouri River. Six immense settling basins were built at that point, and a tunnel was blasted out of solid rock extending to an intake in the main channel of the Mississippi River. During this period the old pumping stations were one by one dismantled and equipped with new and up-to-date machinery, and extensions and additions were built to take care of the rapidly growing water consumption. The engines and boilers installed in the original plants were of massive proportions, and of great reliability, but they were very wasteful in fuel, their duty averaging perhaps 30,000,000 ft.-lbs. Mr. Holman installed new engines and boilers of modern design, which under test developed an average duty of 150,000,000 ft.-lbs., thus saving the city 80% of its former fuel bills.

He also introduced the system of paying a bonus to builders for high efficiencies in pumping engines. His specifications for an engine of a capacity of say 20,000,000 gallons daily, against a head of 125 lbs., with steam of 135 lbs. pressure, called for a duty of 135,000,000 ft.-lbs. per thousand pounds of steam consumed. For each 1,000,000 ft.-lbs. duty greater than that specified the builder was to receive a bonus of $1,000. For each 1,000,000 he fell short there was to be a deduction of $2,000. This arrangement had the effect of keeping out irresponsible and inexperienced bidders, and served as an incentive for high grade work, resulting in splendid performances. This policy has been continued in the department ever since, and has resulted in the making of several famous high duty records.

Another important work undertaken by Mr. Holman was the dividing of the water distribution system of the city into two sections, a special high pressure station at Baden serving the outlying and higher districts, while the original high pressure station at Bissell's Point continued to serve the city proper. He also inaugurated the experiments in water sedimentation and purification with the aid of chemicals, which have since resulted in such marked success. In 1897 he visited Europe for the purpose of making a study of foreign filtration systems.

Mr. Holman's position of Water Commissioner made him a member of the Board of Public Improvements of the city of St. Louis, which had charge of practically all engineering and structural work of a public nature in the city. He was active in all board work, whether connected directly with his department or not, and aided materially in getting the electrical wires under ground in 1898, and also in preparing the specifications and letting the contracts for the lighting of streets, alleys and public buildings. For short periods he served as acting President of that board.

Mr. Holman's administration of the office of Water Commissioner was not free from the usual attempted interferences on the part of practical politicians, who looked upon the appointments in his department as spoils to which the party in power was fairly entitled. To resist these importunities so as to maintain the department on a high working plane, and at the same time preserve amicable working relations with the powers in control, was the most serious problem which confronted him. Without making war on the politicians he nevertheless made it clear that efficiency and not political activity determined an applicant's fitness for appointment, and for retention afterwards. The department reached a high state of efficiency, and its technical and other important positions were always free from political control. Mr. Holman surrounded himself with a carefully selected and trained force of assistants, whose loyalty, energy and ability contributed to the general result. Among these were Messrs. S. Bent Russell, Edward Flad, Ben Adkins—the two latter succeeding later to the office of Commissioner—and Mr. J. A. Laird, his present associate in the office of Holman & Laird, Consulting Engineers.

At the expiration of his third term as Water Commissioner, in 1899, Mr. Holman decided to devote himself to private engineering practice in St. Louis, and opened an office which he continued for two years. In 1900 he accepted the appointment of General Superintendent of the Missouri Edison Electric Co., which operated the largest lighting and power plants in the city. This work he continued until the sale of all the local plants to the North American syndicate in 1904. He then formed a partnership with Mr. John A. Laird, for general private practice in hydraulic and mechanical engineering.

The success of Mr. Holman's administration of the St. Louis water department established his standing as an authority in this field, and led to his being called into consultation regarding similar problems in many other cities, notably Kansas City, Cincinnati, Omaha and Denver. For the city of Omaha he recently designed a complete new system of water-works sufficient for that city's needs for many years. He also submitted recommendations covering the enlargement and improvement of the present water plant. At Denver he is a member of a Board of Appraisers consisting of five eminent engineers, whose duty it is to appraise the value of that water system, and to fix schedules of water rates. Mr. Holman was the only expert from west of the Mississippi River, the others residing in Boston and New York.

He has served two terms as Vice-President of the American Society of Mechanical Engineers, 1894 to 1896, and 1903 to 1905, and was Chairman of the local entertainment committee at the St. Louis Convention in 1896. He is a member of the American Society of Civil Engineers, and was vice-president of the society in 1905-1906. In 1905 he occupied the unique position of being senior vice-president of both the National Societies of Mechanical and Civil Engineers. He is a member of the Engineers' Club of St. Louis, and was its treasurer in 1885 and 1886; vice-president in 1887, and president in 1888. He is an honorary member of the American Water-Works Association. He has been a contributor at various times to the proceedings of local and national engineering societies, and is a clear and interesting writer.

Mr. Holman was married in 1879 to Miss Margaret H. Holland, and has a family of three sons and one daughter.

Mr. Holman has had many other positions of honor and responsibility tendered him, which for various reasons he felt obliged to decline, among them being the chair of Mechanical Engineering at Washington University, and the position of Chief Mechanical Engineer of the Louisiana Purchase Exposition.

His versatility and ability are perhaps best shown by the fact that although educated as a civil engineer, he later mastered both mechanical and electrical engineering, assuming great responsibilities and rendering important services in both these lines.

He is of modest and retiring demeanor, a man of great industry and tact, companionable in every way, and has built up a strong following of loyal friends.

John Hays Hammond: President of the American Institute of Mining Engineers.

By C. E. GRUNSKY,* M. Am. Soc. C. E.

John Hays Hammond is known the world over as a successful mining engineer. He is still in the prime of life, full of vigor and energy, and the activity that leads on to further successes. He is a native of California, the state from which an unusual number of mining engineers have gone forth to do effective work in all parts of the world.

Mr. Hammond was born in San Francisco, on March 31, 1855. His father, Major Richard Pindle Hammond, came from Maryland and served with distinction in the war with Mexico; his mother, Sarah Elizabeth Hays Hammond, was a sister of Colonel John C. Hays, the well-known Texas ranger. Both of his parents were of the stock that helped in shaping the destiny of the young State of California.

Despite the remoteness of this state at the time of gold discovery in 1848, from the rest of the civilized world, and the hardships of the journey to the fabled land of gold, and the cosmopolitan character of the people that there established their homes, there was, despite all this, an immediate and insistent demand for good educational facilities. Good private and public schools, ranking with the best in our country, were soon established, and of these young Hammond received full benefit. His higher and technical education he sought in the East and in Europe. He is a graduate of the class of 1876 from the Sheffield Scientific School of Yale, and has to his credit a three years' course at the Royal School of Mines, Freiburg, Saxony.

His first notable professional employment was under Geologist Dr. George F. Becker, of the United States Geological Survey (Clarence King, Director), in 1880. He was entrusted with the collection of statistics relating to the gold production of California, including general notes on gold-bearing geological formations and methods of mining. The work was being done for the census of 1880. This connection with the Geological Survey, although covering less than one year, made Mr. Hammond acquainted with the mines, methods of operation, and with the miners themselves of a great gold producing section, and he soon found his services in demand by many who hoped to profit by his knowledge and advice. Within a very short time he had established a lucrative practice as a mining expert. He became consulting engineer in mining matters to such establishments as the Union Iron Works of San Francisco, and to the Central and Southern Pacific Railroad companies, and began to reach out into fields beyond California, notably Mexico.

Together with Wm. Ireland, then State Mineralogist of California, he examined the Mulatos mine of Sonora in 1890, after its purchase by Hayward & Hobart from Aguayas & Brother, and confirmed the suspicion that the property had been salted. In this case on the testimony of the experts the purchasers were fortunate enough to recover their purchase money, about $1,500,000.

Mr. Hammond was appointed in 1891 a member of a Commission, together with General A. McD. McCook and Mr. John Barstow, to examine the mineral resources of the Carrizo Mountains, in the Navajo Indian Reservation, but resigned before the work was complete.

In July, 1893, he sailed for South Africa as consulting engineer and mining expert for Barnato Brothers, and his activities were confined to this new field for the next three years. A year or two subsequent to his arrival in Africa, he was consulting engineer to the Consolidated Gold Fields of South Africa, to the British South Africa Company, to the Randfontein Estates Gold Mining Company, and he was also consulting engineer to Cecil Rhodes. As a friend of the latter, he was one of the four leaders in the Reform Movement in the Transvaal and was convicted by the Boer courts of inciting to rebellion and treason, and sentenced to death, after the unfortunate and ill-timed Jameson raid, with which Mr. Hammond was not at all in sympathy. This death sentence was commuted to fifteen years imprisonment and soon thereafter he was liberated upon payment of a fine of $125,000. With the payment of this fine Mr. Hammond's activities in South Africa terminated in 1896, and two years later he was back in the United States.

A matter of interest to geologists is Mr. Hammond's strong advocacy of the theory that the gold reefs of South Africa—the conglomerates of the Witwatersrand and other reefs—were mineralized by ascending solutions. The presence of water-worn particles of gold in the conglomerates is explained as a derivation from pre-existing gold bearing formations, just as the

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quartz pebbles are derived from a pre-existing quartz reef.

While in South Africa, Mr. Hammond, like a number of other American mining engineers, made investments in mining properties which proved profitable and contributed largely to his financial success. Other opportunities for investments in mining offered later. His large acquaintance in financial and mining circles, during a stay in London, preceding his return to the United States, naturally led him into many mining ventures, and he became a stockholder in numerous large mining corporations.

He has found time also to travel extensively and it may be noted that after his journey into Mashonaland and Matabeleland he announced the discovery of King Solomon's Mines in Central South Africa, the genuineness of which has been confirmed, at least partially, by subsequent investigation.

Mr. Hammond's activity has not been confined to furnishing advice and directing mining operations for others; but he has at times himself been at the head of mining companies. He was President of the Bunker Hill & Sullivan Mine in 1901, and, for a year, he directed the working of the Independence Mine of Cripple Creek, having assured to the owners, the Venture Corporation of England, a return of ten per centum on the capital stock (amounting to $488,000). He showed confidence in this case in his judgment that $1,000,000 profits were still in the mine.

Mr. Hammond's prominence and success in mining brought him in contact with the Guggenheim Brothers, and in March, 1903, he assumed the executive position of General Manager and Consulting Engineer of their mining corporation, known as the Guggenheim Exploration Co., whose mining operations have extended to various parts of the world. His business arrangement with that company is still in force.

Mr. Hammond was elected a Fellow of the American Association for the Advancement of Science in 1893; he was made honorary Doctor of Engineering by the Stevens Institute of Technology in 1906; Yale conferred upon him the degree of A. M. in 1898, and in 1907 St. John's College that of LL. D.

As Professor of Mining at Yale, in 1902, he had charge of practical mining work, a course made possible by the "Hammond Laboratory of Mining and Metallurgy," which was a gift from Mr. Hammond to the University and which cost about $135,000.

It may be said of Mr. Hammond that he has been more than ordinarily successful in commanding the confidence of his clients. This has been a material factor in shaping his professional career and has made for him a unique place among the prominent mining engineers of the country.

Mr. Hammond was married on Jan. 1, 1881, to Natalie Harris, of Mississippi, and has three sons and a daughter. He spends a good part of each year at Gloucester, Mass., where he owns a beautiful home overlooking the picturesque bay. For the past two or three years he has spent most of each winter at Lakewood, N. J.; but he will soon follow some of the other mining engineers of South African fame; such as Mr. Hennen Jennings, Mr. Gardner F. Williams and Mr. H. C. Perkins, to Washington, D. C., where he will erect a residence, the land for which has already been purchased.

Mr. Hammond has been a member of the American Institute of Mining Engineers since 1881 and served as Vice-President in the year 1901-2.

Henry G. Stott: President of the American Institute of Electrical Engineers.

Henry Gordon Stott was born in the Orkney Islands, Scotland, in 1866. He received his early education in the public schools and from his father, who was a clergyman, and later in Watson College Schools, Edinburgh. His technical education was obtained in the college of Science and Arts, Glasgow (now the Glasgow and West of Scotland Technical College), specializing in mechanical engineering and electricity.

His first employment after leaving college was in the engine and boiler room of an electric light company in Glasgow. In a short time he received an appointment from the Anglo-American Telegraph Co. as Assistant Electrician on board its steamship "Minia." During the four and a half years in which he held this position, Mr. Stott took part in many deep sea repairs on Atlantic cables, and at the same time did much experimental work on different methods of locating faults in submarine cables; also upon the duplexing of the direct United States Cable Company's main cable, at that time the longest cable (2,750 knots) ever duplexed.

Resigning this position, he joined the Brush Electric Engineering Co. of London as Assistant Engineer, remaining with this company one year. He then went to Madrid, Spain, for Hammond & Co. as Assistant Engineer on power plant, underground cable and installation work for the Cia. Inglesea de Luz Electrica. After completing his work with this company he returned to the Brush Electric Co., remaining there until September, 1891, when he was engaged to put down the underground conduits and cables for the Buffalo Light & Power Co., of Buffalo, N. Y. (later the Buffalo General Electric Co.). Upon the completion of the underground cable system he became Engineer for the company, and did much notable construction work there, including the design and erection of a new power plant on Wilkeson St.

On March 1, 1901, Mr. Stott was appointed Superintendent of Motive Power of the Manhattan Railway Co., operating the elevated railways of New York City. In this position he had charge of the completion of the 74th St. power plant, substations and transmission lines. He organized the entire operating force of this new department, and upon the lease of the Manhattan System by the Interborough Rapid Transit Co. in 1904, he was appointed Superintendent of Motive Power for that company, taking charge of the erection and construction work at the 59th St. power plant.

This department has charge on both the elevated and the subway divisions, of the power-houses, high tension transmission lines, sixteen substations, and the low tension transmission lines to the third rail.

Mr. Stott is the author of many papers, the most important being "The Conversion and Distribution of Received Currents," read before the American Institute of Electrical Engineers; "Steam Pipe Covering and Its Relation to Station Economy," read before the Association of Edison Illuminating Companies; and "Power Plant Economics," read before the American Institute of Electrical Engineers and published in Engineering News of Feb. 8, 1906. He has given a series of lectures in the Brooklyn Polytechnic Institute on "Power Plant Design and Operation," and also before the Engineering Society of Columbia University. In addition to the Presidency of the American Institute of Electrical Engineers, to which he was elected in May, 1907, he is a Manager of the American Society of Mechanical Engineers; a member of the National Advisory Board on Fuel and Structural Materials; Vice-President of the New York Electrical Society, and a Member of the Engineers' Club and the Wykagyl Country Club.

RESPONSIBILITY FOR FLOODING THE SALTON SINK in Southern California, during 1904-5, has been placed on the California Development Co., by a decision of the U. S. Circuit Court. Damages to the amount of $476,746 have been awarded to the New Liverpool Salt Co., whose works were destroyed by the floods, and a permanent injunction against diverting from the Colorado River any more water than is needed for irrigation has been issued. In the course of his decision Judge Wellborn said:

> That the waters which overflowed complainant's land and destroyed its property were largely, if not entirely waters diverted from the Colorado River through defendant's intakes. The defendant was negligent in not selecting proper places for such intakes, and in not providing suitable headgates to control the flow of the water through the intakes. Such negligence was the direct and proximate cause of the overflow of complainant's lands, and the resultant loss of property.

Defendant's claim that the floods of 1905 in the Colorado River would have overflowed the banks of said river and submerged complainant's lands, even if its intakes had not existed, is, it seems to me, without merit. In the first place, the contention is a pure speculation, not susceptible of proof. Furthermore, in view of the fact that complainant's land had never before been inundated, except in 1891, and then not so as to destroy or greatly impair the value of complainant's property, and the further fact that the floods of 1905 were frequent and of close recurrence, it is not an improbable conjecture that the scouring of the bed of the river by the floods, had they not been deflected by the intakes, would have so deepened the channel that the waters would have found their way into the gulf rather than into the Salton sink.

Press dispatches state that the decision may prove to be a barren victory, inasmuch as the California Development Co. has transferred all its real estate to the Southern Pacific, in settlement for moneys advanced and aid rendered in closing the break in the banks of the Colorado River.

THE INCREASING OF FLOOR SPACE has been accomplished at the factory of the Pantasote Leather Co. at Passaic, N. J., in an expeditious and space-saving manner. It became necessary about a year ago to enlarge the factory, which consisted of a two-story main building with a one-story wing, without disturbing to any great extent the operations of the plant. It was decided to gain the additional space by building around the one-story wing a two-story reinforced concrete structure of much larger floor space. This was carried out as planned with a total shut-down of work in the old building of but two days, in which time the foundations for the concrete columns were constructed. As it was necessary to continue the operation of the machinery, the shafting had to be temporarily supported after the old walls were torn down. To do this, special centers were made which acted at the same time as forming and falsework for the concrete beams and supports for the shafting. Although this method is to be criticized because it subjects the setting concrete to constant vibration from the moving machinery and thus retards its setting and perhaps impairs its final strength, so far as can be learned no evil results have been noted. For the column forms special framing was designed in which the four vertical side forms were held together by notched sticks extending along each side and tied together with wedges. The absence of nails made the dismantling of the forms very easy and increased the salvage in the lumber. The entire structure, adding about 42,000 sq. ft. floor space to the plant, was completed in about 80 days. Mr. Charles B. Waterhouse of Passaic, N. J., was the architect and Salmond Bros. Co., Arlington, N. J., the contractors. The above information has been furnished us by Mr. C. M. Ripley.

REPORT ON THE NEW YORK BARGE CANAL WORK BY THE SUPERINTENDENT OF PUBLIC WORKS.

On Jan. 20, Hon. Frederick C. Stevens, Superintendent of Public Works, made public his annual report to the Legislature in which he laid bare the slow rate of progress on the New York 1,000-ton barge canal and declared that the enterprise would be obsolete before its completion and that nothing short of a Federal deep waterway from the Lakes to the Hudson would adequately meet the demands of future transportation.

We print portions of the report of most interest as follows:

PROGRESS OF WORK UNDER BARGE CANAL CONTRACTS.

There are some features of the barge canal work, which for several reasons, principally the lack of proper progress, I deem it my duty to bring to your attention.

All told, to date, there is work under contract aggregating in amount $22,342,277. In extent these contracts cover the practical completion of the prism, side walls and incidental structures of the canal for a distance of 131.29 miles; the erection of 26 bridges, and the construction of 24 locks and 14 dams. All of this work, with the exception of that embraced in Contracts 12, 14 and 35, was under contract prior to January 1, 1907. Since the alinement of the canal at all points has not as yet been decided, it is impossible at this time to say what percentage of mileage or of locks, dams, bridges and other structures is actually under contract.

Only a very small portion of the work embraced in the contracts already let has been done and the rate of progress from the start has been small. The total amount of work under contract in dollars and cents is a little more than 20% of the estimated cost of the whole, and the amount of work done, as shown by the payments made on estimates, is only about 20% of the amount under contract, or 4% of the whole.

While the progress of actual work has not been satisfactory, no less to me than to the public and particularly those especially interested in the new waterway, under the provisions of the law, the Superintendent of

Public Works is powerless to take initiative in any steps intended to effect a change in this particular.

I have given a somewhat close study of the causes for this lack of progress, and in my judgment, several causes have contributed:

First, a lack of sufficient capital by the contractors;

Second (and this in some cases may be closely allied to the first cause), employment of machinery totally inadequate for the doing of the work in hand;

And third, a knowledge on the part of contractors that since only about 20% of the whole work is under contract, no good reason exists for confining them to their contract periods since, even if completed, the portions of the canal embraced within their contracts could not be utilized until the completion of the whole work.

That the final completion of this improvement is so indefinitely postponed and that the time which, under the most hopeful conditions, must be consumed in bringing it to completion, constitute a distinct and deep disappointment to canal and commercial interests is fully appreciated, and this regret and disappointment are shared in by me.

PROBLEMS INVOLVED IN BARGE CANAL CONSTRUCTION.

Without assuming to criticise any of those connected with the problems whose solution is necessary for the completion of the waterways on lines prescribed by statute, I feel obliged to state that to my mind an inadequate study was given to the problems presented before the actual construction work was begun, and not only is the unwisdom of this course already apparent, but it is, I believe, emphatically contrary to the intent of the statute authorizing this improvement.

Section 6 of chapter 147 of the Laws of 1903, the so-called Barge Canal Act, after providing that the work authorized to be done shall be done by contract, provides:

> Before any such contract shall be made the State Engineer shall divide the whole work into such sections or portions as may be deemed for the best interests of the State in contracting for the same, and shall make maps, plans and specifications for the work to be done and materials furnished for each of the sections into which said work is divided and shall ascertain with all practicable accuracy the quantity of embankment, excavation and masonry, the quantity and quality of all materials to be used and all other items of work to be placed under contract and make a detailed estimate of the cost of the same, and a statement thereof with the said maps, plans and specifications, when adopted by the Canal Board, shall be filed in his office and a copy thereof shall be filed in the office of the Superintendent of Public Works and publicly exhibited to every person proposing or desiring to make a proposal for such work.

As set forth in the schedule above, there is under contract at the present time work in excess of $22,000,000. Whether this is in round numbers 22% of the whole work to be done, I do not believe any person having to do with the improvement can more than hazard a guess, excepting it be based on a comparison of the original estimate that the whole work was to cost $101,000,000. The $22,000,000 plus of work is divided up into 21 contracts. There are in existence one or two contracts aggregating from three to four million dollars, but the average thus far is about $1,000,000. On this basis it could be predicted that the whole of the work will be found to be divided into 100 "sections or portions." This means so far the cost to the State of 21 construction plants, and on the same basis in the future will mean the cost to the State of a total of 101 construction plants.

I have given above as one of the possible reasons for the unsatisfactory progress of the work, the inadequacy of plant. It is conceded by those familiar with the class of work to be performed and conditions to be met with that on some of these contracts there would need to be an initial outlay of from one hundred to three hundred thousand dollars for plant and equipment. The contractor having a million dollars' worth of work in hand might see his way clear to secure a proper equipment if there could be guaranteed him at the completion of his initial contract additional work at the same or similar prices where his plant and outfit could be utilized.

No such assurance, however, can be given. As the contractor undertakes the work for what profit there may be found to be in the doing of the work, he is met at the very threshold with the necessity for economizing in outlay for plant and equipment. This method may be, as it has been argued, in the interest of the small contractor; but even this is to be doubted, and certainly it is not in the interest of the State and of the proper progress of the work.

You are all familiar with the desire expressed by pro-canal interests immediately upon the adoption of the referendum, authorizing this work, of seeing actual operations begun. While this may have been very proper as expressing interest and emphasizing enthusiasm, I believe it to have been shortsighted as a business policy. Aside from the cost of plant by multiplicity of contracts, aside from uncertainty as to final cost, aside from very many disadvantages which might be cited, the cost to the State in the matter of engineering and other supervision must be greatly increased as a result of any increase in the construction period.

Nothing so well illustrates the fact that the lapse of time, in some cases a very short time, changes the aspect of things so far as public improvements go, as does the canal improvement project.

In 1894 the most wistful and the most hopeful of canal advocates had their ambition bounded by a 9-ft. canal. When this work came to an unfortunate and fortuitous end, before the State could adjust itself the demand was for an entirely different improvement, the outcome being the 1,000-ton Barge canal.

The type of the Canadian canals is very similar to the proposed Barge canal, but they were found to be unsuited to present conditions, and even before construction work was begun on the Barge canal, the Dominion Government had set about to make important changes in the physical condition of the locks and structures to better meet the growing demands of commerce.

The canal as proposed in 1903, is not the canal which is now contemplated. Already by amendment, the locks of 28 ft. in 1903 have been widened to 45 ft. Other changes including those of alinement have been made. While I refer to those things, not to criticise but to commend, nevertheless, they teach the lesson that in some features at least the Barge canal project had not been so carefully thought out and its adjustment to the needs of the State so carefully considered as should have been the case.

These facts make all the more emphatic the question and are sufficient reasons for asking whether the Barge canal as now planned, by the time it is completed, will fully answer the purpose for which it is intended?

The last ten years have seen not one but several revolutions in the transportation problem. In 1880, it was believed a no-toll canal would restore to New York her commercial supremacy. This restoration hardly outlived the accomplishment of the fact. In 1903, a 9-ft. canal, it was thought, would serve as a restorer. In 1903, a 1,000-ton barge canal with locks 28 ft. wide, it was thought, would suffice. Two years later the demand had so grown as to require and justify a 45-ft. lock.

Undoubtedly had the 9-ft. improvement been accomplished, in the two or three years following, 1894 and 1895, there would have followed a period of boat and barge construction and such an increase in canal shipments as would have been most gratifying to the State and people. Any project in prospect diminishes in its aspect with nearer approach. Could the Barge canal have been an accomplished fact within three or four years from the date of authorization, though the 28-ft. lock eventually would have been found to be inadequate, the improvement would have proved a boon to shipping interests and would have enhanced the commercial glory of the Empire State.

Could the canal as now proposed, with its 45-ft. wide lock, be an accomplished fact within two or three years, so that there could be no loss by transition from the old to new, such as seems to threaten, the benefit to be derived might be such as to satisfy the present generation, but who can tell how far it will go in accomplishing the desired results if the completion period is to be deferred for ten years or even so few as six years.

Never was so much study given to the subject of artificial waterways by practical men, men who do things and are not dreamers, as is being given to that subject today. Not until very recently has commerce, as represented by its commercial leaders, taken up for serious consideration the suggestion of the hydraulic engineers for the utilization of this country's rivers, lakes and valleys as commercial highways. Suggestions which, ten years ago, if made, would have been credited to the dreamer, are today regarded as eminently practical, by men of affairs; but in such matters it is the future that is had in view, not yesterday, today or even tomorrow. Had this plan been followed in the past, fewer millions would have been wasted in what today are regarded as useless or practically useless water highways.

The canals of Ohio have been abandoned as inadequate. The Illinois-Mississippi canal only just completed, after 15 years of construction work, is found to be practically obsolete though this structure has locks 35 ft. wide and 170 ft. in length. Fifteen years ago this project was thought to be ambitious but already the boats which may be operated on this canal with profit are too large to pass through the locks.

At the inception of the Barge canal the purpose was to restore to New York State the traffic which had been taken away as a result of a better system of Canadian canals. The Barge canal may be suited to compete with the present type of Canadian canals but the Dominion Government has foreseen the need of a different type and has undertaken to supply it in the so-called Ottawa-Georgian Bay route. Surveys have been completed and plans and estimates of the cost for a 21-ft. ship canal have been prepared, connecting Georgian Bay with the St. Lawrence River by way of Ottawa and Mattewa rivers. The Dominion Parliament is expected to make an appropriation for the construction of this canal during its present session. The Ottawa-Georgian Bay canal is planned to provide the shortest outlet by water for the grain, forest and mining products of the great Northwest, and it is potent to ask whether with that route for shipment once open, commerce can be changed so as to take the route through the lower lakes and across the State of New York, particularly such commerce as is bound for European ports? Commerce, history tells us, when once lost is difficult to restore.

Canada in the race for commerce must be dealt with as a rival. The simplicity of the Ottawa-Georgian Bay route, from the standpoint of construction as viewed by engineers, taken in conjunction with the methods which that government applies to the solution of any project looking to enhancing the glory of the Dominion, threatens, if they do not fully insure the completion of this waterway before the Barge canal under the present system of construction can be completed.

Commerce once lost under such conditions, if not forever lost, would be hard to regain. Not only New York but the whole nation is interested in retaining supremacy in this regard.

Here then is the problem. What is the solution? I would not for a moment delay any energy that may be brought to bear to a completion of adequate waterways and a utilization of the magnificent rivers and lakes and the facilities which New York State has to offer in this regard to a full utilization of the Great Lakes traffic. Before the Barge canal had been seriously considered, the Federal Government took note of the opportunities offered by New York State for the construction of a deep waterway. Careful surveys and estimates were made by the Board of Engineers on Deep Waterways, and submitted in 1900. The estimate was for a ship canal, 21 ft. deep, connecting Lake Erie with the tide waters of the Hudson River, the estimate being $198,000,000, divided as to that part of the canal connecting Lake Erie with Lake Ontario, $42,500,000; and to that part connecting Lake Ontario with the Hudson River tide waters by way of the Oswego and Mohawk river route, $155,500,000.

The route from the Hudson River to the westerly end of Oneida Lake was practically that being followed by the Barge canal. The route from that point to Oswego, however, paralleled the Oswego River rather than canalizing it. This latter, however, is a mere matter of detail. Such a canal, instead of accommodating barges of 1,000 tons burden, will accommodate craft with a carrying capacity of 8,400 tons.

It is my belief that the Federal Government could very easily be induced to revive its interest in the deep waterway along the lines of its 1900 survey. Nothing could be lost to New York State in glory by a Federal contribution and the carrying out of plans along lines adequate for the future as I have endeavored to present herewith.

The inevitable conclusion to my mind as, I believe, it will be to the mind of every fair minded man who makes a careful study of this project and eliminates all consideration of locality, is that your honorable body should without delay memorialize Congress to join with New York in making that portion of the Barge canal route from the Hudson River by way of the Mohawk River, Oneida Lake and Oswego River, a ship canal of the type contemplated in the government surveys of 1900, and that this memorializing of Congress should be followed by such pressure from those interests within our State as may not be ignored, to the end that the plans suggested may be accomplished. The construction of the connecting link between Lake Erie and Lake Ontario could be wisely left to the Federal Government, for when this improvement was once considered, no other argument, it seems to me, would be necessary to accomplish the necessary legislation.

This suggestion is not made, and may not be honestly construed by any person, as a plan to delay construction work on the Barge canal now in progress. The cost to the State, if its completion could be consummated, would not be greater than will be the cost of completing the lesser waterway, and the benefits to result not only immediate but for the future will be a hundred-fold.

If this enterprise is undertaken along the lines of this suggestion and at once, practically none of the moneys expended or about to be expended by the State on the Barge canal route named will have been misspent.

If this plan could be brought to fruition, it is my belief that not only would New York State be in a commanding position so far as commercial shipments go in the event of the completion by the Dominion Government of the Ottawa-Georgian Bay canal; but it is not impossible that if the construction of the ship canal across New York State were authorized in the near future, the construction of the Ottawa-Georgian Bay canal would be abandoned altogether for the time being. The net result to the State would be a 21-ft. canal from the Hudson River to Lake Ontario instead of a 12-ft. canal, with adequate locks and other structures, with a possible adjustment of operating expenses favorable to New York State, and in addition, a completion at an earlier day than may be hoped for in the case of the Barge canal as now planned. Finally, but not the least item of consideration, a solution of the water traffic problem so far as New York is concerned for all time. The suggestion I have made, if carried out would not involve any abandonment of plans or the work now under way for the construction of a Barge canal from Buffalo to Oneida Lake, or of the Champlain canal from Whitehall to Waterford.

ENGINEERING NEWS

A Journal of Civil, Mechanical, Mining and Electrical Engineering

Published every Thursday by

THE ENGINEERING NEWS PUBLISHING CO.

220 BROADWAY, NEW YORK

BRANCH OFFICES

CHICAGO: 1636 Monadnock Block
WASHINGTON, D. C.: Home Life Building
ATLANTA: Candler Building
RUDOLF MOSSE, BERLIN AND HAMBURG, GERMANY

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Entered at the New York Post-Office as Second-Class Matter.

In our issue of Dec. 12 we urged that the Federal Government, if it undertakes the systematic improvement of waterways on the large scale which public opinion now generally favors, should turn its attention to the Deep Waterway from the Great Lakes to the Atlantic.

We record with much gratification that in New York State itself, public sentiment is awakening to the folly of the 1,000-ton barge canal enterprise to which the State is at present committed and the need of a larger waterway, to be built by the Federal Government is coming to be appreciated. At Utica, N. Y., on Dec. 26, the Central New York Farmers' Club adopted resolutions whose purport is summed up in the following:

Resolved, That we deem it unwise and inexpedient to continue work upon the thousand-ton barge canal and we request our representatives in the Legislature to use their best efforts to secure by bill or resolution a suspension of operations and further expenditure of money on this enterprise.

Resolved, That we believe the transportation and commercial interests of the State and nation will be best promoted by the speedy construction of a federal canal connecting Lake Ontario at or near Oswego with the Hudson River at or near Troy, of such dimensions as will permit the passage of any craft in service on the great lakes.

We have no doubt that this expression is representative of a large body of intelligent public opinion throughout the state. With the exception of Buffalo and New York City, public sentiment in the state opposed the barge canal enterprise at the outset. Yet we saw little chance that the legislature would give heed to the protest above voiced.

On Jan. 20, however, there appeared an official statement regarding the barge canal enterprise from a source that cannot be ignored. Hon. Frederick C. Stevens, Superintendent of Public Works of New York, comes out boldly in his annual report in favor of the Federal Deep Waterway. He says:

The inevitable conclusion to my mind, as, I believe, it will be to the mind of every fair minded man who makes a careful study of this project and eliminates all consideration of locality, is that your honorable body should without delay memorialize Congress to join with New York in making that portion of the barge canal route from the Hudson River by way of the Mohawk River, Oneida Lake and Oswego River, a ship canal of the type contemplated in the government surveys of 1900, and that this memorializing of Congress should be followed by such pressure from those interests within our State as may not be ignored, to the end that the plans suggested may be accomplished.

Elsewhere in this issue we present an abstract of Mr. Stevens' report, in which he shows that work on the barge canal has progressed so slowly that only a trifling amount, barely 4% of the total, has been completed. It is by no means too late, therefore, for New York to retrace her steps. She can if she chooses complete the 1,000-ton barge canal from Troy to Lake Champlain and from Buffalo eastward to a junction with the Federal deep waterway near Oneida Lake, leaving to the vastly greater resources of the Federal Government, to which the task properly belongs, the work of creating a channel that shall give the Lake shipping an outlet to tidewater.

The wonder is, not that nearly 200 persons perished in the fire and panic in a theater at Boyertown, Pa., on Jan. 13, but that such holocausts are not more common than they are. It is the almost universal rule that the audience rooms for public meetings in villages and in all cities save those of considerable size, are located on the upper floors of buildings, are reached by narrow and often by winding stairways, have usually only a single door for entry and exit and are contained in combustible wooden structures. Lighting and heating apparatus are usually such as to involve large fire risks, and it is common to fill the rooms on occasion with booths and decorations which are as inflammable as tinder.

These things are done through pure ignorance, and without a thought of the risk that is run. Do not engineers resident in such communities owe a duty to the people among whom they live; and should they not use their influence for the safeguarding of all such public assembly rooms, whenever opportunity occurs?

We are well aware that protests are often ineffectual and that comparatively few people appreciate any danger that is not directly before their eyes. The Boyertown holocaust, however, is an object lesson which may be used with convincing force by any engineer who is arguing for the safeguarding of public buildings.

The destruction by fire of the 12-story Parker Building in New York City, a week ago, as described in our last issue, ought by no means to shake confidence in fireproof construction. As we stated last week, from late information received just as we were going to press, the steel floor beams and girders in that building had their lower flanges unprotected by fireproofing. Every engineer knows that the strength of a beam depends solely on the ability of its lower side to resist tension and knows also that steel heated above a temperature of some 600° rapidly loses its strength. Even below 600° there is a reduction in elastic limit of about 4% for each 100° rise in temperature.

It is a misnomer, therefore, to call a building "fireproof" which has a steel frame with the tension side of its floor members exposed to the attack of heat. Such a building has, of course, an advantage in that the structure itself is not combustible. If the contents of the building offer little for the flames to feed upon, such a building might possibly come through a moderate fire without serious injury, since the metal of the beam will for a time conduct heat away from the lower flange. However, the additional cost of suitably protecting the beam flanges is so small that no valid excuse for omitting it can be imagined.

A quarter century ago, when arches of ordinary bricks between steel beams represented the best that could be done in fireproof construction, floor-beam flanges were left bare because no way was known of protecting them. It is disgraceful that the precedent of that day should be made an excuse at the present time for the erection of structures which pretend to be proof against the attack of fire and are not.

We call attention to these facts in the interest of safe construction and without diminishing in any way the warning given last week, that buildings containing stocks of inflammable materials, like the Parker Building, ought to have the additional safeguards of automatic sprinklers and fire wall divisions, no matter how good their construction.

The insurance committee of the New York Merchants' Association has appealed to the Board of Aldermen for the passage of the new building code now before that body. While some parts of this new code have been generally, and we think properly, criticised, it contains undoubtedly many provisions of great value. Some of these are quoted as follows by the above-mentioned committee:

First—The proposed code very properly limits to a maximum of 150 ft. the height of a fireproof building occupied for such purposes as was the Parker Building, and if the height exceed 100 ft. the building must be protected with a standard equipment of automatic sprinklers.

Second—The aggregate floor space would, under the new code, have been divided in two by a standard fire wall, with or without standard fire doors, from behind which the firemen could have fought a blaze on any floor even if the sprinklers had proved insufficient.

Third—It is stated that the fire mounted from the sixth floor to the top by shooting out of the windows of the south and east sides and overlapping into corresponding windows in the floors above. The wired glass windows in metal frames or the standard automatic tin clad shutters required by the revised code would have prevented this and materially assisted to confine the fire to the sixth floor.

Fourth—It is probable that segmental arches on five-foot centers would have supported the machinery which broke through the flat floor arches in the Parker Building and fell floor by floor to the basement.

Fifth—Had the building not been equipped with automatic sprinklers, but limited, in such event, to 100 ft. in height, still the floor area would have been subdivided by the fire wall referred to and each floor would have been properly equipped with standpipe and hose so that the spread of the fire, encouraged by the disgraceful condition of the Fire Department's hose, could have been minimized by the building's own fire fighting equipment and might have been extinguished thereby before it gained headway.

We presume there are many among our older readers who clearly recall the heated arguments which were carried on more than a quarter century ago over the relative merits of riveted and pin-connected bridges, or as it used to be called British and American bridge practice. One seldom hears even a whisper of that old-time controversy, for the excellent reason that the two schools of design have—to all intents and purposes—coalesced. Nobody defends any more as first-rate design the light, short-span pin bridges that were so common a generation ago. Of course there may be conditions where difficulties of transportation and erection in remote districts may warrant the use of such a bridge; but the superiority of the riveted girder or truss is conceded. On the other hand, even the European engineers have learned the great advantage of pin connections in the erection of long span structures, particularly where such structures have to be put in place over rivers which are subject to floods.

These being the well-known facts, it will doubtless surprise many of our readers to find in this issue a paper by Mr. Geo. H. Thomson, formerly Bridge Engineer of the New York Central & Hudson River R. R., with the suggestive title "Riveted Lattice for Railroad Bridges of Maximum Span." It is proper to say here that the publication of a contribution in Engineering News does not imply that the editors are in agreement with the opinions expressed by the author. In the present case, for example, we are as far as possible from coinciding with some of Mr. Thomson's views; and yet many of the things which he says present such food for thought, that his paper cannot be regarded otherwise than as a contribution to the literature of bridge design which is very well worth presentation.

Mr. Thomson's paper is frankly and radically reactionary. If anything is well-settled in modern bridge engineering, it is the careful analysis of stresses in members and details; and hardly less firmly fixed, in America at least, is the acceptance of the pin-connected bridge for spans exceeding 200 ft. Yet Mr. Thomson flatly rejects both "pin-connected design" and what he calls "strain-sheet engineering." His attack on the former cannot be misunderstood, for he opposes uncompromisingly every use of pins and eye-

bars in bridges. His denunciation of "strain-sheet engineering" is not so clear. On its face it is directed against the only known method of designing bridges, namely, the study of loads, the analysis of stresses due to these loads, and the proportioning of members and details to resist these stresses. But, of course, bridges cannot be designed "by eye" or by mere genius, and this Mr. Thomson knows as well as anyone. His term "strain-sheet engineering" is probably meant to denote the practice of calculating static stresses (and only primary stresses), proportioning by formulas to suit these stresses, and calmly forgetting all differences between the relation of load to material in the bridge and the relation of load to material in the testing-machine. Many details of practice which may be characterized in a similar way will occur to the reader, for example the custom of joining the ends of compression members by a few weak plates and then optimistically relying on complete central transfer of stress across the joint and on satisfactory resistance of the splice at the joint to all incidental bending and distorting action.

Mr. Thomson's paper is so far from being constructive in its criticism, however, that the precise scope of even its destructive comment is uncertain. Does the author object to designing from stress-sheets only when the designer lacks the mental eye for the mechanical nature of the structure he is engaged on? If so, what specific features are to be secured by the use of this mental eye; what specification can be drawn to ensure the exercise of this faculty? In particular, must we rely entirely on instinctive feeling to estimate safely the severity of action of a railway train crossing the bridge? Are we wrong in providing for impact by an empirical formula and letting the uncertainties of this provision go into the margin of safety? Is there any reason to look for more satisfactory results by the substitution of riveted connections for pins, if only the same degree of intelligence be used? Does the use of pin connections have some occult influencing in debasing the designer's engineering judgment or skill in detailing? The reader is left quite at sea in these matters, and all that he clearly reads from the article is that Mr. Thomson credits the riveted bridge with greater mechanical perfection and therefore greater reserve of strength than the pin-connected bridge.

With all this uncertainty, however, we feel sure that every engineer concerned with the design of steel work can read Mr. Thomson's expressions of opinion with profit. Apart from any merit or lack of merit in the argument itself, there is value in the article simply as a sincere statement of opposition to some generally accepted methods and practice. A statement of opposition can frequently serve as a valuable reminder of easily-forgotten caution. Thus, it is likely that many of the younger engineers have definite faith in their calculated stresses as something that accurately measures the resistance developed in the metal, in terms of testing-machine loads, and take no stock in solidity or rigidity except as measured in terms of calculable stress.

Perhaps we may venture to interpret a little more clearly Mr. Thomson's advocacy of "lattice engineering" by recalling the articles on railway bridge failures published in Engineering News some ten years ago by Mr. Chas. F. Stowell, M. Am. Soc. C. E., of Albany, N. Y. It was shown then by Mr. Stowell that the typical American pin-connected railway bridge most often fails not by overload but by having some of its members crippled by derailed rolling stock or blows from displaced freight.

The "lattice school" teaching, we judge, is that it is better to sacrifice the idea of making the stresses in each member of a structure absolutely determinate, for the sake of having more than one member to rely on in an emergency. It is better, they say, to support a load by several members, even if you can't tell how much each carries, than to put the whole on one member with the certainty that the whole bridge will go down if that member is knocked out.

THE CHICAGO HARBOR, LAKE FRONT IMPROVEMENTS AND TRAFFIC TERMINALS.

It would be a great pity if the present agitation in Chicago over the relative desirability of increased harbor facilities and of the development of the lake front for park purposes should result in permanent injury to either one of those two great public causes. Elsewhere in this issue we give the main facts bearing directly on the two sides of a possible controversy, which controversy we trust the good sense and public spirit of Chicago citizens will avert. Briefly, the question at issue is: Shall the harbor facilities of Chicago be restricted to the Chicago and Calumet rivers and their adjacent lake fronts, leaving practically the whole of the frontage on Lake Michigan for park purposes, or shall about six miles of the lake front, south of the Chicago River, be made a harbor for lake shipping and developed with docks, piers and railway terminals? Plans are being prepared for filling in portions of the lake off-shore from the six-mile stretch just mentioned, thus forming lagoons and land areas which would serve as a combined land and water park. Mayor Busse urges that the harbor needs of the city would thus be sacrificed to "beautification."

The advocates of park improvements reply to Mayor Busse that the comprehensive plan for municipal improvements now being developed by Mr. D. H. Burnham, acting for the Chicago Commercial Club, make ample provision not only for harbor facilities but also for improved and increased railway terminals. Some of the questions at issue are local, although of great general interest because of the principles involved; but a number of them are of national concern, since they involve such far-reaching matters as the levels of the Great Lakes and the Lakes-to-Gulf Waterway.

Among the local questions of general interest are the Drainage Canal in relation to both the sewage disposal and the water supply of Chicago, and comprehensive schemes for the development of a general city plan to meet the traffic needs of the city by land and by water, and also to satisfy the demands for a city made healthful and beautiful by means of open spaces which give opportunity for fresh air and recreation and satisfy the eye and elevate the mind by presenting the natural beauties of earth, water and sky.

As we have stated more than once, the general plan of most cities is a very haphazard congerie of streets, laid out to meet the exigencies of the short-sighted real estate holder and speculator rather than to afford direct and convenient passageways to important business or residence sections. Where convenience and quickness of passage has been neglected, it is no wonder that breathing spaces and esthetic possibilities have been so generally overlooked. To the credit of American cities it must be said that a large proportion of them have made some provision, often fairly adequate in mere extent, for public parks; but only within the past five years or so has there been a general awakening to the need of a comprehensive plan to serve as an ideal for each city to strive towards. As a result of this awakening a considerable number of cities, more generally through the action of civic organizations than through their city officials, have secured reports and plans for opening or widening main thoroughfares, and for parks and playgrounds, with connecting parkways and boulevards.

Chicago, through its Commercial Club and Mr. Burnham, is now at work on a plan of general city improvement. Quite unintentionally, we presume, Mayor Busse has struck a blow at the good work just outlined, not only by coming forward with a harbor plan that would take the heart out of the lake-front development, but also by giving the impression that "mere beautification" is being given precedence to needed commercial facilities.

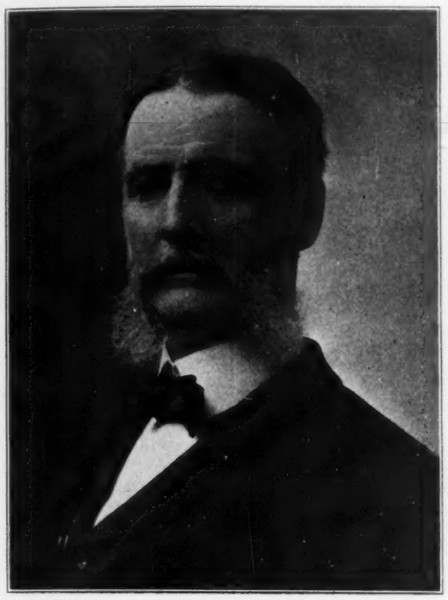
Perhaps a check is needed to the ardor of those who see in the Chicago lake front an opportunity for public breathing spaces, recreation grounds and land and water park developments unparalleled elsewhere in the world; and unparalleled, too, in both opportunity and need. But if a check is needed it should certainly be applied with great discretion, lest a noble project of civic improvement be thwarted or dwarfed and urgent needs of the city be sacrificed.

It should be remembered that Chicago covers an immense area of flat, uninteresting territory, broken only by sluggish rivers, repellent to the senses instead of inviting. Its water front is, therefore, its only opportunity for relief from the monotony of the prairie. Water-front parks and park strips, are always far more attractive than ordinary park areas, even when such areas, by their relative elevation, command pleasing prospects. When, as at Chicago, the inland parks differ from the dead level of surrounding city areas only by their clothing of grass, flowers, shrubs and trees there is a great reason for seizing the water-front possibilities and developing them to their utmost.

Great as the water-front park needs and opportunities of Chicago may be, no one can reasonably advocate any undue sacrifice thereto of harbor and other commercial demands. We say undue sacrifice, because this is a world of give and take, and a compromise on both sides of this question may be necessary for the greatest ultimate good.

The Chicago situation cannot be fully appreciated without a general understanding of existing harbor facilities, the purpose of the Chicago Drainage Canal, and the relation of the latter to the Lakes-to-Gulf Waterway project. To-day the Chicago River is virtually the harbor of Chicago. The stream is narrow and crooked. It is obstructed by bridge piers, but these obstructions are being removed or lessened. The opening of the Drainage Canal (see map with article elsewhere in this issue) and the continuous diversion through the river to it, for purposes of sewage dilution, of large volumes of lake water increase the velocity in the river and with it the difficulty of handling boats in such restricted quarters. Obviously, as Colonel Bixby points out in an able report to which we have made reference elsewhere, every boat tied to a wharf on the river front or passing through the river increases the velocity of the latter and makes navigation more difficult. The sewage disposal demands of the city, as population grows, will increase the volume of river flow, and, therefore, the velocity, up to the limit permitted by the War Department, whatever that may be ultimately. If the Drainage Canal is made a connecting link between Lake Michigan and the Mississippi River the further demands upon the Chicago River will be limited only by the size of the boats used for through traffic—a point yet to be determined. Colonel Bixby urges that the Chicago River, as a feeder to the Drainage Canal, cannot be made to serve more than one of the three purposes: Sewage disposal, harborage, and through navigation. He assumes that it is impracticable to widen the river channel, owing to the cost of acquiring land and buildings on the river and also to difficulties that would arise if building foundations were disturbed. For these reasons, and because of the already unsatisfactory condition of the river as a harbor, he made plain his opinion before Mayor Busse came into office, that a harbor should be developed on the lake front.

These opinions of Colonel Bixby, as well as those of Mayor Busse, are certainly entitled to serious consideration. At the same time, it should be presumed that the members of the Commercial Club of Chicago have the welfare of the city at heart, and that, as their representative, Mr. Burnham is framing plans to conserve all the interests of the city. Those plans, we understand, provide for additional harbor facilities at the mouths of the Chicago and Calumet rivers. What volume of traffic could be accommodated by harbors at these two points we cannot pretend to say. But there appear to be strong arguments in favor of the two locations, as opposed to the great lake-front scheme of Mayor Busse, quite aside from the park questions at issue.



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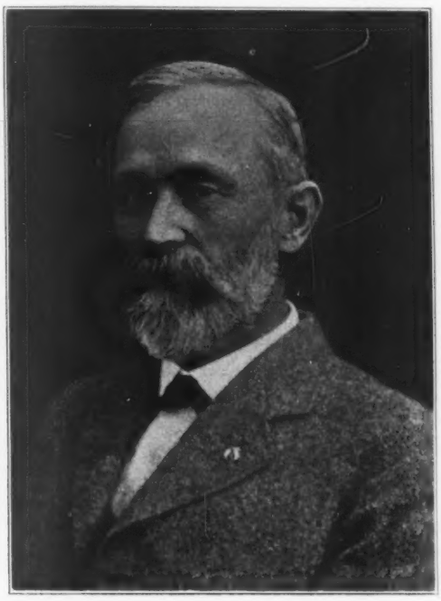

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Further than this, however, an important point to be emphasized by those who would study the future needs of Chicago, or any other great commercial terminal, where transfer is made between rail to water transportation, is *avoid concentration*. All our railway terminals, in times of normal traffic, at least, are in a state of chronic congestion. It is the delays of handling in terminals that ties up cars, delays freight and thus costs the railways and ultimately the public untold millions of dollars every year.

Railway freight terminals were originally located near the centers of cities when the cities were comparatively small. They now occupy real estate too valuable for the use to which it is put, and further expansion is impossible. Every far-seeing railway officer realizes to-day that better terminal facilities, and more ample area for handling traffic at the great cities, are necessities of the immediate future.

Now any intelligent development of water terminal facilities can only be made with full regard to the needs of the railways and manufactories which furnish traffic for the shipping. A harbor on Lake Michigan's water front would only be worth while if the railway terminals which feed it with traffic can be brought close beside it. We do not see how this is at all possible at Chicago. The real estate in the locations represented by Michigan Ave. and Drexel Boulevard is far too costly to be taken for railway switching yards.

The true location for future freight transfer between railways and shipping at Chicago, it seems to us, must be far away from the crowded center of the city. Very likely the rapid river currents may ultimately compel the removal of all wharves fronting on the channel of the river itself. The river, then, will be made use of only as a passageway to reach a great network of docks and basins, excavated in the broad low-lying territory adjacent to the river and the drainage canal and west of the area already built up and improved.

Here will be the future site, surely, where the lake steamers and the vessels of shallower draft navigating the future "Lakes-to Gulf" waterway will meet to exchange cargoes. Docks and basins can be artificially excavated at this site, we feel confident, at less cost than piers and wharves can be built in a lake-front harbor, and the abundant area of cheap land will give ample space for adjacent railway terminals.

THE CAMERON SEPTIC TANK PATENT DECISION.

We can think of no patent decision that would be a greater surprise to the sanitary engineers of the United States than the one rendered on Jan. 7, 1908, by the U. S. Circuit Court of Appeals, declaring that the *process claims* of the Cameron septic tank patent are valid. From the earliest descriptions of Mr. Donald Cameron's Exeter experiments to the present time, the sanitary engineers of the United States have assumed that septic action and the essential features of the septic tank had been so long known and used that neither the process nor the apparatus for its utilization could be covered by valid patents. These opinions seemed fully substantiated when, less than a year ago, the U. S. Circuit Court declared invalid, both the process and the apparatus claims of the Cameron patent, so far as the apparatus claims were questioned in connection with the septic tank at Saratoga Springs, N. Y.

But the one judge of the lower court has now been overruled by three judges of the higher court; and since in patent litigation there is rarely an appeal to the U. S. Supreme Court, the present decision, we understand, is final.

A reading of the final decision, reprinted elsewhere in this issue, will show how sweeping is the victory of the American holder of the Cameron patents. Although the apparatus claims are again denied, yet the process claims, as conceived by Cameron and the framer of the United States Cameron patent, are sustained in no uncertain terms, not only as regards the septic process alone, but also as to the process in combination with (1) aeration and (2) aeration and filtration.

The attitude of American engineers in the past towards the septic tank patents should not be interpreted either as showing a lack of perspicacity on the one hand or a lack of respect for patents on the other, although as to the latter it would be useless to deny that American sanitary engineers and professional sanitarians generally, since they rarely take out and still less rarely exploit patents, do look somewhat askance at patents on sanitary processes or apparatus secured by others. As to lack of perspicacity, the common application of the term, "glorified cesspool," to the septic tank goes far towards explaining why any person, engineer or not, should fail to see anything patentable in the septic tank. In addition, various tanks used for sewage treatment and a number of patents on processes or apparatus resembling the septic tank, all antedating the Cameron patent, have combined to strengthen the belief that neither the septic process nor the septic tank and its adjuncts were patentable. The fact that both the lower and higher courts are united as to the unpatentability of the septic apparatus is a further defense, if any be needed, against the charge of a lack of perspicacity on the part of engineers who have ignored the septic tank patents.

The process claims, the higher court asserts, all base on Cameron's recognition of the value of separating the activities of anaerobic and aerobic bacteria, and providing just the kind of a "workshop" for anaerobic bacteria that is exactly suited to their needs; a "workshop" characterized by the absence of air and light and in which motion is reduced to a harmless minimum.

The opinion in the latest decision raises many interesting questions regarding what does and what does not take place in a septic tank, and also the far more interesting practical question: when is a sewage tank not a septic tank?

The questions of most immediate importance, however, are: (1) what is to be the attitude of the Cameron Septic Tank Co. toward the many cities, towns, villages, institutions, industrial plants and householders who have infringed the septic process patent; and (2) what is to be the future attitude of engineers and of municipal officials towards the septic process and the monopoly of its use established by the U. S. Circuit Court of Appeals?

The general attitude of the company is reflected in a letter which we have received from its manager, Mr. Wyllie, which we reprint here as of great interest to our readers:

Sir: Referring to our conversation in your office a few days ago regarding a recent decision of the U. S. Circuit Court of Appeals, sustaining Cameron, Commin & Martin's Patent No. 634,423 for process of treating sewage:

Public sentiment generally having been directed in an opposite direction, it is possible that the publication of this decision may create something of a sensation; some engineers may even go so far as to resent what may appear to them a dangerous monopoly, and one liable to detrimentally affect their business interests. Any such apprehension is, however, entirely unwarranted; the Cameron Septic Tank Co. has at all times invited the cooperation of engineers, and will continue to do so; but as long as it was believed that we were claiming something that did not belong to us, there was no common ground on which we could meet, and public money was often wasted in useless and unnecessary experiments.

As the original promoter of the septic tank process in the United States, the action of the U. S. Circuit Court of Appeals is peculiarly gratifying to me, because it emphasizes the distinction between a simple "process of nature," which can be applied by anyone of ordinary intelligence, and a process so subtle in its character that notwithstanding all that has been said and written about it, its fundamental principles have not been generally recognized, and it has taken nearly five years of litigation to arrive at a correct understanding of just what those principles imply.

It seems to me, therefore, that instead of being a menace, the decision should be recognized as a protection to the engineering profession as a whole, and a very decided benefit to the country at large, for as long as any doubt existed as to the really fundamental principles of the process, principles not only involving the validity of the patents, but their proper application, there was nothing to prevent the installation of septic tank systems of doubtful efficiency; septic tank systems which, while conforming in a general way to the principles laid down by Cameron, were inadequate to produce the results possible when those principles are properly applied. The septic tank process when properly applied we all know produces wonderful results; if improperly applied it can become an intolerable nuisance.

As the owner of the Cameron patents, the Cameron Septic Tank Co. naturally expects to recover from infringing plants, but its demands will be reasonable; and for future installations a cordial invitation will be extended to engineers to take advantage of its experience in treating different kinds of sewage under varying conditions, on terms that should promote rather than retard the application of a system that has not only revolutionized the art, but has made it possible to avoid a source of pollution to rivers, streams and other sources of water supply, fast becoming a menace to the public health.

Yours very truly, H. D. Wyllie,
General Manager, Cameron Septic Tank Co.
Monadnock Block, Chicago, Ill., Jan. 17, 1908.

While the foregoing statement contains, naturally, nothing specific as to royalties or to the latitude of engineers in the design of plants which make use of the septic process, yet its general spirit of reasonableness in the exercise of the rights established by the patent is highly commendable.

As to the future attitude of engineers and municipal officials towards the septic process, that will depend very largely upon the specific royalty terms and other conditions offered by the company. One thing is certain: unless the advantages given by the victory just obtained are used with all the moderation that a liberal interpretation of Mr. Wyllie's statement would imply, most engineers and municipalities will avail themselves of methods of sewage treatment that do not involve septic action. Valuable as the process may be under some conditions, it is far from indispensable and there are many engineers, chemists and biologists who have looked on it with increasing doubt from the outset. We are well aware that this has been partly due to the possibilities of patent litigation, which, however remote, had to be reckoned with until the validity or invalidity of the patent was determined, but such contingencies have been only an added weight in balancing the advantages and disadvantages of the septic process. If, as it is only fair to conclude from Mr. Wyllie's statement, moderate terms are offered for the settlement of infringement claims and for future royalties on present and prospective use of the patents, then the septic tank may gain rapidly in favor.

An important consideration in the matter of royalty terms for future installations will, of course, be the freedom granted to engineers to adapt the septic tank process to accord with their own ideas and with the teachings of the many experiments with the septic tank, alone and in combination with various filters, made all over the world, at public expense, during the past ten years. Nothing would meet with greater resentment than an attempt to dictate the engineering design and construction of sewage works in which it was desired to utilize the septic process.

We cannot conclude these notes without a word of congratulation and appreciation for the inventor of the septic tank, that modest, genial Scotchman, Donald Cameron, of Exeter, England. Whatever opinion one may hold regarding such patents as the one under discussion, Mr. Cameron undoubtedly deserves great credit for the contribution he has made to the art of sewage disposal. His associates, Mr. Martin and Mr. Commin, also deserve credit for the enterprise and ability they showed in extending the use of the septic tank throughout the world. Mr. Wyllie and his American associates likewise deserve commendation for the grit and skill they have shown in winning a victory against such odds as they encountered. Credit should also be given to the small municipalities, headed by Saratoga Springs, that showed such determination to establish their legal rights in the premises, as well as to the engineers and lawyers who so ably assisted them.

LETTERS TO THE EDITOR.

Concerning an Arch of Quicksand.

Sir: One of our enterprising Chicago newspapers has some engineering news from New York City that may be news to Engineering News. I quote verbatim as follows:

ENGINEERS BUILD ARCH OF QUICKSAND.

What is regarded by engineers as one of the most wonderful achievements ever undertaken in subterranean construction now is nearing completion in the McAdoo tunnel beneath the junction of Sixth Ave. and Ninth St. At that point four tunnels come together. Overhead is the Sixth Ave. "L" and the Sixth Ave. surface road and crosstown surface cars.

Under the direction of Charles M. Jacobs, chief engineer of the Hudson Companies, which is constructing the tunnels with no inconvenience to surface traffic, a great arch of sand sixty-eight feet wide has been built by compressed air at the point where the tunnels come together.

The arch is of quicksand and it is proposed to make this 68-ft. quicksand arch permanent with concrete, and when this has been done it will sustain the tremendous weight of the street overhead, with its great volume of "L," surface car, and vehicular traffic.

An arch of quicksand would certainly be a "wonderful achievement." We engineers in the West would like to make quicksand "arch" in some of our works, but it doesn't have the arching habit. Perhaps the New York engineers are dealing with reinforced quicksand.

Yours truly,

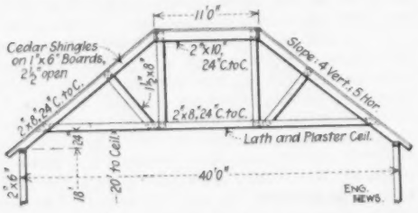
"Tunnel Builder."

Chicago, Ill., Jan. 2, 1908.

[According to our best information the "arch of sand" referred to by our correspondent has been beneath it a lot of husky timbering and steel beam supports to say nothing of lagging.—Ed.]

The Sea Gate Garage: Dome Action in Four-Hipped Roofs.

Sir: I was much interested in your article on the garage at Sea Gate, Coney Island, in your issue of Dec. 12, 1907, which reminded me of a timber roof over a court-house which I erected in British Columbia a number of years ago. It was a hipped roof, 40 × 41 ft., and had a flat deck, as shown in the sketch herewith.



The architects of the building took no notice of the fears which I expressed as to its safety; and I left the falsework or scaffolding, from which it was erected, in place as long as possible. When the roof was completed and we were prepared to lath the ceiling, I had the props removed carefully, while watching for signs of settlement, and I was much relieved that none could be detected anywhere.

The hip-rafters were about 26 ft. long, and as they sagged greatly even under their own weight, they were propped up to position and held there during erection. I anticipated considerable tension in the wall plates, which were 2 × 6-in. doubled, from thrust at the feet of the hip-rafters, and they were lapped and spliced carefully. Since this time I have watched the construction of such roofs (smaller, of course) by carpenters, and I have noticed that the hips are usually made up by piecing out some of the common rafters by nailing pieces of boards to join them together at the ends, and of such length as not to prevent the attachment to them of the jack-rafters. These pieces could by no means be considered as splices; yet I have seen no ill effects from their use.

Returning now to the subject of your discussion and the diagonal girders A which Mr. Miller found from the assumptions of his analysis to be so highly stressed, I have no hesitation whatever, as a result of the above observations, in saying that until their separation from the roof slab those girders were actually carried by the roof slab, and that they are now subject to no transverse stress other than from their own weight.

It is easily conceivable that, if the four sides of this roof were to be cast separately, and were of such strength as to sustain their own weight when resting horizontally upon their three outer edges, and if they were then brought to position on the walls (no column being used) and held together by being tied near the outer corners, they would be in a stable condition. Their upper edges would be in close contact, and deflection would be resisted by bending stresses in their inclined planes. The lever-arms of such stresses would be very large, and little deflection would take place if the slope of the roof be not very flat. Such is the condition of this roof. The girders A were not stiff enough to prevent their being carried by the roof slabs, and the slabs are now relieved from this useless stress. It is quite likely that, had the horizontal reinforcement not been placed at the eaves, the roof slabs would have separated enough at the corners of the building to allow the diagonal girder to have carried the weight of the roof as intended; but such a contingency must be prevented now, as this girder has been separated from its top flange.

The condition of the normal girders B, C, D and E must be rather serious, as they are supported at their upper ends only by the steel reinforcement, which delivers their reaction to the ridge of the slabs. They cannot be considered to abut one another, as the angle between them is somewhat less than 90°.

A better design for this roof would have been to omit the central column, and to form a deck of about one-third the dimension of a side. This would reduce the length of the longer girders; and the deck would be heavily cambered, which would reduce the reinforcement required, owing to the pressure against it of the sides. There would be no attempt to provide a ridge other than that required to provide for the unbalanced condition of the shorter girders meeting there. The eaves would be reinforced to provide lower chords for the roof slabs of the adjoining sides, which might be considered as the end posts of a truss delivering their load there; and also to provide for the bending moment in the plane of the inclined sides, which would otherwise be a horizontal force to be resisted at the top of the supporting walls.

In describing the timber structure above, I should have pointed out that there were no ties or ceiling joists in the opposite direction to that shown in the sketch. As this portion of the building would be rarely heated, I have seen it carrying the accumulated snow fall of months (which in the Kootenay district of British Columbia is very heavy) which easily attained 25 to 30 lbs. per sq. ft. I may also state that I consider the 2 × 8-in. ceiling joists of this roof to be in compression, rather than tension, due to their connection to the rafters, as the rafters would otherwise bend a good deal under the dead and snow loads alone, a condition which would be further aggravated by tension in the ceiling joists, and such bending has not taken place. I could never account for this roof remaining standing except by the assumption of such stresses as I have indicated above, and it appears to me that such stresses could easily be provided for in concrete construction.

Yours truly, D. J. McLachlan,

Calgary, Alta, Dec. 26, 1907.

[Doubtless such dome action, as described, not only may occur but in some degree must occur in cloistered or four-hipped roofs, provided there are adequate means for resisting the ring tension at the eaves and on any horizontal section. But the trouble is that no reliable method is available for calculating the dome stresses or for designing such roofs on the basis of dome action, and in default of this it is probable that the safe course is to make the roof strong enough to stand without dome action. Moreover, in concrete work it would be necessary to arrange reinforcement and conduct the concreting in such a way as to develop the ring strength on all horizontal sections, which would not necessarily be done in all roofs built like the garage which we described.—Ed.]

Notes and Queries.

Attention has been called to four typographical errors in Tables I and II of the article on "Cost of Constructing Steam-Driven Electric Power Plants" by Mr. Frank Koester. On Table I the totals should read $65.50 and $92.00 instead of $65.00 and $103.00 respectively. In Table II the cost of switchboards should read $2.00 and $3.50 instead of $1.00 and $2.00. The totals of Table II then remain as quoted.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

A constitutional amendment of vital importance to the administration of the society was considered at the annual meeting of the American Society of Civil Engineers, held in New York City on Wednesday, Jan. 15, 1908. This amendment aims to transfer the election of new members from the general body of corporate members to the Board of Direction. At present only Juniors and Honorary Members are elected by the Board, while the election to all other grades (Member, Associate Member, Associate) and the transfer from the grade of Junior to a higher grade is done by letter-ballot of the membership; and it requires only 20 adverse votes to defeat a candidate. It has long been urged by a part of the membership that this method of election is not only ineffective as a means of careful selection of candidates, but keeps out many prominent and estimable civil engineers who through their very prominence have made enemies, the latter taking occasion to display their enmity by blackballing them. Efforts have been made repeatedly to put the matter on a broader basis, and one of these efforts, a few years ago, resulted in raising the number of adverse votes required to defeat a candidate to 20 (it had previously been 7). Even with this change the conditions objected to were not much bettered, since few professional men of prominence have kept so clear of enemies that 20 votes could not be mustered against their admission to the society. Moreover, this knowledge of this condition has repeatedly induced the Board of Direction to reject an application for admission, i. e., withhold it from presentation to the membership, because of their fairly certain feeling that the vote of the membership would reject the application. Several flagrant illustrations of this occurred during the past year or two. The satisfactory or unsatisfactory working of the present rules of admission is therefore not exhibited by the proportion of rejections to admissions on ballot. It was stated during the meeting by the Secretary, in answer to a question, that the percentage of rejections on ballot has been very small; but this statement does not include reference to the number whom the Board of Direction refused to pass to ballot.

The constitutional amendment designed to change the manner of election was presented by Past-President B. M. Harrod in association with a number of others. Its essential clause is as follows, being the clause which specifies the manner of election of candidates after the question of their eligibility has been canvassed by the Board of Direction:

> Art. III., Sec. 3. . . . the Board of Direction . . . shall consider these applications, . . . shall classify the applicant with his consent, and on application for admission shall vote thereon by ballot.
>
> Sec. 4. The ballots shall be letter-ballots, in a form to be prescribed by the Board of Direction. They shall be mailed to each member of the Board of Direction and shall state the date on which the ballot is to be canvassed. This shall be not less than 20 days after the issue of the ballot. At least 25 votes must be cast to constitute an election. Five or more negative votes shall exclude from election. In case of exclusion no notice thereof shall be entered on the minutes, but the candidate shall be notified.

Several amendments to other clauses of the constitution, of such character as to carry out completely the intent of the Harrod amendment and remove all contradictory passages from the constitution, were offered by Mr. C. S. Gowen (Ossining, N. Y.), and by vote of the meeting they were incorporated with the amendment. The main question being then before the meeting, a letter from Mr. Harrod was read, giving detailed reasons in favor of the adoption of the amendment. Mr. Clemens Herschel (New York City) thereupon made an address in opposition; while he, with the author of the amendment, deprecated the condition which permits petty spite to blackball an eligible candidate, he declared that the transfer of the power of election to the Board of Direction is not the proper way to change this condition, as it takes out of the hands of the members the vital feature of control of the society—the control of the membership. He characterized the proposed method as aristocratic, comparing it with the democratic principle of leaving to the membership the control of its own growth. Referring to the methods of election of several other societies to which he belongs, Mr. Herschel suggested that a proper arrangement would be to require that the number of adverse votes necessary for rejection should not be less than one-fifth to one-fourth the total number of votes cast; that is, on the basis of 500 voting, at least 100 blackballs should be required to defeat a candidate. The amendment was also opposed in a letter from Prof. F. H. Eno (Columbus, O.), who urged that under the proposed system a little-known candidate would have a much better chance of election than a well-known man.

On the other hand Lt.-Col. Wm. M. Black (Havana, Cuba) and Mr. John F. Wallace (New York City) sent letters strongly favoring the

amendment, and Mr. E. L. Corthell cabled from London his support.

Prof. G. S. Williams (Ann Arbor, Mich.) then raised the question whether the amendment in requiring for rejection five adverse votes in the Board of Direction, out of a minimum of 25 votes, does not make rejection too difficult. He advocated the substitution of "two" for "five," for the expressed reason that good and sufficient grounds for rejecting a candidate might not be known to five Directors, but would be known to two. This being proposed as an amendment to the amendment, it came to a vote of the meeting and was defeated.

Mr. Clemens Herschel thereupon again took the floor, and, reiterating his strong disapproval of the amendment, suggested that it be laid on the table. The Chair (President Benzenberg) declaring this to be impossible because not permitted by the constitution clauses governing the procedure of dealing with amendments, Mr. Herschel moved to add to the amendment an enacting clause specifying that it shall take effect in 1999. This motion, though seconded, was ruled out of order, on the ground that it is not pertinent to the subject-matter of the amendment. Reference to the constitution showed that the only disposition that can be made of a proposed amendment, after discussion at a general meeting, is to submit it to letter-ballot, unless it be referred by the meeting to a committee to report at the following general meeting of the society. Upon this basis, Mr. Herschel, declaring his desire to delay the matter, if it could not be defeated outright or tabled, moved to refer the amendment to a committee of five to be appointed by the President, the committee to report at the next general meeting. Prof. Williams supporting the motion, it was put to a vote and carried.

Another amendment, much less important in nature, however, then came up for consideration. But as the course followed in proposing this amendment had been somewhat irregular, as the proposal had been sent to the Secretary later than the period fixed by the constitution, the Chair ruled that it could not be considered at the present meeting.

COMMITTEE REPORTS.

Several of the technical committees of the society reported to the meeting, either by presenting preliminary results or by reporting progress. Most important was the report on steel rails.

SPECIAL COMMITTEE ON RAIL SECTIONS.—While the report is only preliminary, it presents two important results: the specifications for composition and manufacture, presented at the general meeting of July 9, 1907, was again recommended with but one change, namely, in the specified percentage of manganese in open-hearth rails; and a statement of the principles which must govern the improvement of rail shapes was submitted. The corrected specifications are as follows. Their important clauses, besides those stating chemical composition, are (1) the clause calling for 25% minimum discard from top of ingot, and (2) the clause requiring one drop test from each heat, this test to be taken from the top of the ingot.

Recommended Specifications for Bessemer Steel Rails.

Process of Manufacture.—The entire process of manufacture and testing shall be in accordance with the best state of the art, and the following instructions shall be faithfully executed:

Ingots shall be kept in a vertical position in the pit heating furnaces until ready to be rolled, or until the metal in the interior has had time to solidify.

No bled ingots shall be used.

There shall be sheared from the end of the blooms formed from the top of the ingots not less than 25%, and if, from any cause, the steel does not then appear to be solid, the shearing shall continue until it does. If, by the use of any improvements in the process of making ingots, the defect known as piping shall be prevented, the above shearing requirements may be modified.

The number of passes and speed of train shall be so regulated that on leaving the rolls at the final pass, the temperature of the rail will not exceed that which requires a shrinkage allowance at the hot saws, for a 33-ft. rail of 100-lb. section, of 6/16 ins., and 1/16-in. less for each 5-lb. decrease of section. These allowances to be decreased at the rate of 1/66-in. for each second of time elapsed between the rail leaving the finishing rolls and being sawn. No artificial means of cooling the steel shall be used after the rails leave the rolls, nor shall they be held before sawing for the purpose of reducing their temperature.

Chemical Composition.—Rails of the various weights per yard specified below shall conform to the following limits in chemical composition:

	Weight of Rail, Lbs. per yd. 70-79	80-89	90-100
	%	%	%
Carbon	0.50 to 0.60	0.53 to 0.63	0.55 to 0.65
Phosphorus shall not exceed	0.085	0.085	0.085
Silicon shall not exceed.	0.20	0.20	0.20
Sulphur shall not exceed	0.075	0.075	0.075
Manganese shall not exceed	0.75 to 1.00	0.80 to 1.05	0.80 to 1.05

Drop Test.—One drop test shall be made on a piece of rail, not less than 4 ft. and not more than 6 ft. long, selected from each blow of steel. The test piece shall be taken from the top of the ingot. The rails shall be placed head upward on the supports, and the various sections shall be subjected to the following impact tests under a free falling weight:

70 to 79-lb. rails	18 ft.
80 to 89-lb. rails	20 ft.
90 to 100-lb. rails	22 ft.

If any rail breaks, when subjected to the drop test, two additional tests may be made of other rails from the same blow of steel, also taken from the top of the ingots, and if either of these latter rails fail, all the rails of the blow which they represent will be rejected, but if both of these additional test pieces meet the requirements, all the rails of the blow which they represent will be accepted.

The drop-testing machine shall have a tup of 2,000 lbs. weight, the striking face of which shall have a radius of not more than 5 ins., and the test rail shall be placed head upward on solid supports 3 ft. apart. The anvil block shall weigh at least 20,000 lbs., and the supports shall be part of, or firmly secured to, the anvil. The report of the drop test shall state the atmospheric temperature at the time the test was made.

Section.—The section of rail shall conform, as accurately as possible, to the templet furnished by the railroad company, consistent with the paragraph relative to specified weight. A variation in height of 1/64-in. less, or 1/32-in. greater than the specified height, and 1/64-in. in width will be permitted. The section of rail shall conform to the finishing dimensions.

Weight.—The weight of the rails will be maintained as nearly as possible, after complying with the preceding paragraph, to that specified in contract. A variation of one-half of 1% for an entire order will be allowed. Rails will be accepted and paid for according to actual weights.

Length.—The standard length of rails shall be 33 ft. Ten per cent. of the entire order will be accepted in shorter lengths varying by even feet to 27 ft., and all No. 1 rails less than 33 ft. long shall be painted green on the ends. A variation of ¼-in. in length from that specified will be allowed.

Drilling.—Circular holes for splice bars shall be drilled in accordance with the specifications of the purchaser. The holes shall conform accurately to the drawing and dimensions furnished, in every respect, and must be free from burrs.

Straightening.—Care must be taken in hot-straightening the rails, and it must result in their being left in such condition that they shall not vary throughout their entire length more than 5 ins. from a straight line in any direction, when delivered to the cold-straightening presses. Those which vary beyond that amount, or have short kinks, shall be classed as second-quality rails and be so stamped.

Rails shall be straight in line and surface when finished—the straightening being done while cold—smooth on head, sawed square at ends, variation to be not more than 1/32-in., and, prior to shipment, shall have the burr occasioned by the saw cutting removed, and the ends made clean. No. 1 rails shall be free from injurious defects and flaws of all kinds.

No. 2 rails shall be accepted up to 5% of the whole order. They shall not have flaws in their heads of more than ¼-in., or in the flange of more than ½-in. in depth, and, in the judgment of the inspector, these shall not be so numerous or of such a character as to render them unfit for recognized second-quality rail uses. The ends of No. 2 rails shall be painted white, and shall have two prick-punch marks on the side of the web near the heat number brand, and placed so as not to be covered by the splice bars. Rails from heats which failed under the drop-test shall not be accepted as No. 2 rails.

Branding.—The name of the maker, the weight of the rail, and the month and year of manufacture, shall be rolled in raised letters on the side of the web; and the number of the blow shall be plainly stamped on each rail where it will not subsequently be covered by the splice bars.

Inspection.—The inspector representing the purchaser shall have free entry to the works of the manufacturer at all times when the contract is being filled, and shall have all reasonable facilities afforded him by the manufacturer to satisfy him that the finished material is furnished in accordance with the terms of these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment.

The manufacturer shall furnish the inspector, daily, with carbon determinations for each blow, and a complete chemical analysis every 24 hours, representing the average of the other elements contained in the steel, for each day and night turn. These analyses shall be made on drillings taken from small test ingots. On the request of the inspector, the manufacturer shall furnish drillings for check analyses.

Recommended Specifications for Basic Open-Hearth Steel Rails.

The specifications for rails made by the Basic Open-Hearth process shall be the same as for Bessemer rails, excepting that a full chemical determination shall be furnished for each heat and two drop tests from each. Their chemical composition shall be:

	Weight of Rail, Lbs. per yd. 70-79	80-89	90-100
	%	%	%
Carbon	0.53 to 0.63	0.58 to 0.68	0.65 to 0.75
Phosphorus shall not exceed	0.05	0.05	0.05
Silicon shall not exceed.	0.20	0.20	0.20
Sulphur shall not exceed	0.06	0.06	0.06
Manganese shall not exceed	0.90	0.90	0.90

Joseph T. Richards, Chn.
Chas. W. Buchholz,
S. M. Felton,
John D. Isaacs,
R. Montfort,
H. G. Prout,
Geo. E. Thackray,
E. K. Turner,
Wm. R. Webster,
Robert W. Hunt, Secy.

In the matter of rail sections, while stating that it is not yet prepared to recommend definite shapes, the committee set forth the following as governing principles for the design of rail sections heavier than 60 lbs. per yd.

Requirements for Rail Sections Heavier Than 60 Lbs. per Yd.

a. There should be such a distribution of metal between the head and the base as to ensure the best control of temperature in the manufacture of the rail.

b. The percentage of metal in the base of the rail should preferably be equal to or slightly greater than that in the head, and the extremities of the flanges should be sufficiently thick to permit the entire section to be rolled at low temperatures. The internal stresses and the extent of cold straightening will be reduced by this means to a minimum, and at the same time the texture of the section will be made approximately homogeneous.

c. The sections should be so proportioned as to possess as great an amount of stiffness and strength as may be consistent with securing the best conditions of manufacture and the best service.

d. The following limitations as to dimension details of the sections are considered advisable for the various weights per yard:

1. The width of base to be ½-in. less than the height.
2. The fishing angles to be not less than 13° and not greater than 15°.
3. The thickness of the base to be greater than in the existing sections of corresponding weight.
4. The thickness of the web to be no less than in the existing Am. Soc. C. E. sections of corresponding weight.
5. A fixed percentage of distribution of metal in head, web and base for the entire series of sections need not be adhered to, but each section in a series can be considered by itself.
6. The radii of the under corner of head and of top and bottom corners of base to be as small as practicable with the colder conditions of rolling.
7. The radii of the fillets connecting the web with head and base to be as great as possible, for reinforcing purposes, consistent with securing the necessary area for bearing surface under the head for the top of the splice-bar.
8. The sides of the head should be vertical or nearly so.
9. The radii of the top corners of the head should not be less than 5/16-in. so long as the wheels continue under the present standard of the Master Car Builders' Association.

The same principles have been recommended to the American Railway Association by its Committee on Standard Rails and Rail Sections, and as the association has submitted to its members a uniform series of blanks upon which full details of rail failures are to be reported, the society's committee, which expects to have access to these reports also, hopes to be able shortly to present a full series of sections for the heavier rails. The reports of rail failures are expected to be the more valuable because several large railways are having or will have rails rolled to designs differing among themselves but all based on the principles above stated.

This committee report was passed without further discussion, the committee continuing.

COMMITTEE ON CONCRETE AND REINFORCED CONCRETE.—A progress report by the committee on Concrete and Reinforced Concrete stated that the committee expects to present a preliminary report at the next annual meeting (January, 1909).

COMMITTEE ON UNIFORM TESTS OF CEMENT.—The Cement committee reported that it is considering several important details of cement testing, among them a standard sand, form of tension briquettes and compression test-pieces, percentage of water, and tests for soundness. Several minor changes in the 1904 specifications (Eng. News, Jan. 29, 1903, p. 109) for testing cement were recommended. The method of chemical analysis proposed by a committee of the New York section of the Society of Chemical Industry (Eng. News, Vol. 60, p. 60, July 16, 1903) was recommended, a specific form of boiler for the soundness test was described and shown, etc. In the paragraph on Significance of Chemical Analysis, the clause which declares 5% magnesia and 1.75% sulphuric anhydride harmless is to be omitted. The committee continues.

COMMITTEE ON ENGINEERING EDUCATION.—The progress report by the committee on Engineering Education laid emphasis on the need for considering this subject very deliberately. The committee was appointed only since the annual meeting of January, 1907.

OTHER BUSINESS.

The question of whether or not it is advisable that a special committee be appointed on Underground Piping has been before the Board of Direction during the past year. A report from the Board to this meeting gave reasons for and

against appointing such a committee, and recommended that no committee be appointed. This recommendation was adopted by the meeting.

PRIZES.—Upon nomination of its Committee on Prizes, the Board of Direction made awards for papers read during the past year as follows:

The Norman medal to Mr. L. M. Cox (Louisville, Ky.) for his paper "The Naval Floating Dock, Its Advantages, Design and Construction."

The Thomas Fitch Rowland prize to Mr. James D. Schuyler (Los Angeles, Cal.) for his paper "Recent Practice in Hydraulic-Fill Dam Construction."

No award of the Collingwood Prize for Juniors was made, as also occurred last year.

NOMINATING COMMITTEE.—On the basis of suggestions received from the members residing in the several districts, the meeting voted the following to be appointed members of the Nominating Committee. These appointments are for two years, except in the case of District 4, where an extra vacancy occurred.

Dist. 1. Charles H. Staniford, New York City.
2. Alexis H. French, Brookline, Mass.
3. David A. Watt, Albany, N. Y.
4. P. M. Sax, Philadelphia, Pa., 2-year term.
4. J. N. Chester, Pittsburg, Pa., 1-year term.
5. Andrew O. Cunningham, St. Louis, Mo.
6. Arthur Hider, Greenville, Miss.
7. Herbert S. Crocker, Denver, Colo.

ELECTION OF OFFICERS.—The letter-ballot vote for officers of the Society resulted in the election of the official ticket, as follows:

President, Mr. Charles MacDonald, New York City.
Vice-presidents, Mr. Mordecai T. Endicott, Washington, D. C.
Prof. George F. Swain, Boston, Mass.
Treasurer, Mr. Joseph M. Knap, New York City.
Directors, Mr. Charles L. Harrison, New York City.
Mr. George W. Kittredge, New York City.
Mr. Dexter Brackett, Boston, Mass.
Mr. Horace Andrews, Albany, N. Y.
Prof. Gardner S. Williams, Ann Arbor, Mich.
Mr. Charles S. Churchill, Roanoke, Va.

ANNUAL REPORT.—The administrative report of the Board of Direction and the report of the Treasurer, as usual, record the advance of the Society in a statistical way. We extract the following items as having special interest.

Net increase of membership: Honorary members, 3 (loss); members, 143; Associate members, 246; Associates, 14; Juniors, 95; Fellows, 1 (loss); total, 494. This exceeds by 116 the increase in any previous year, and represents 12.61% of the membership at the beginning of the year. The Present membership is 4,411, of which 2,218 are of the grade of Member, and 1,441 of the grade of Associate Member.

Financially also the Society is in very good condition. Its receipts during the year were $98,467.96 and its regular expenditures $81,-634.79. In addition, a payment of $10,000 on the mortgage covering the house of the society was made, leaving a net surplus of $7,433.17. The present cash balance is $20,749.28. The inventory surplus over and above its debt of $165,000, is $373,918.63. The Treasurer stated at the meeting that since the close of 1907 a further payment of $10,000 has been made on the mortgage.

The library now includes 48,165 volumes, and specifications, maps, drawings, photographs, etc., to the number of 10,468.

EXCURSIONS AND ENTERTAINMENT.—A visit was paid to the Pennsylvania R. R. cross-town tunnels through New York City, under the guidance of engineers engaged in the work. Thursday, Jan. 16, was devoted to a steamer trip to the Blackwell's Island cantilever bridge which is now in process of erection for the Department of Bridges of New York City.

A reception on the evening of Jan. 15, and a smoker on the following evening, were not the least enjoyed features of the meeting.

THE CHICAGO HARBOR AND WATER-FRONT PARK IMPROVEMENT QUESTION.

A number of important engineering, commercial and esthetic questions relating to the harbor of Chicago and the parking of the lake front are now attracting no little attention in that city. Some of our readers may know that after hard-fought litigation Chicago established its title, a few years ago, to a considerable extent of lake frontage. Since then it has, by one means or another, acquired title to additional frontage, so that it now owns some 14 out of 20 miles of its frontage on Lake Michigan. Recent legislation authorizes the South Park Commission to acquire nearly all the frontage remaining in private ownership. Portions of the frontage acquired have already been laid out as parks or boulevards, and plans for continuing this work are being made. These plans are included in comprehensive studies for the esthetic and practical improvement of the general city plan of Chicago now being made by Mr. D. H. Burnham, the well-known Chicago architect who has done so much notable work of this sort for various cities during the past few years. Mr. Burnham, as we understand it, is working with the backing, financial and otherwise, of the Commercial Club of Chicago.

A local stir was created in Chicago early in the present month by a communication sent to the city council by Mayor Busse, in which a protest is made against devoting practically the whole of the Lake Michigan water front to park purposes and a plea is made for creating a large harbor along shore, south of the Chicago River. A plan showing the whole park system of Chicago, present and proposed, including lake-front improvements and projects, and also showing Mayor Busse's proposed harbor, as submitted to the city council by the mayor, is reproduced herewith. We also reprint Mayor Busse's message to council, as follows:

I desire to call your attention to the pressing need of giving careful and comprehensive consideration at the earliest possible date to the question of Chicago's harbor facilities. It is a notorious fact that the lake commerce of Chicago, once the pride and boast of this city, has been steadily decreasing for a number of years. This city now, I believe, ranks fourth in lake commerce, where once it stood first and far ahead of its nearest competitor. Without counting the ore shipments from the iron beds of the northwest, the city of Duluth, which is but a pigmy compared with Chicago, and which serves as a distributing center for a much smaller territory, ranks about even with this city in general lake commerce.

The one and only reason for Chicago's decline in this respect is the inconvenience and inadequacy of its harbor facilities. We have been inclined to rest easy in the belief that the tunnels formed practically the only obstruction to commerce in the Chicago River and that the lowering of the tunnels will end all of our difficulties in this respect. I agree with many who have studied this question, that the tunnels constitute only a small part of the conditions which hamper shipping in the Chicago River.

Even with the tunnels lowered to any depth, the largest boats in use on the Great Lakes would still find it difficult to make free use of the Chicago River on account of its narrowness and crookedness. Many millions of dollars could be spent in straightening and widening this river without making it in any degree adequate for the demands of lake commerce that ought to come to Chicago, for so long as we have bridges across the river —and we cannot do without the bridges—boats will be delayed in coming in and going out, and every such delay means a hampering of commerce in the matter of time and also the high towing charges, which are a burden upon the freight carriers.

The time has come when Chicago must decide whether it will depend for the future entirely upon the harborage afforded by the Chicago River and the Calumet River, or whether it should not take steps to utilize at least some portion of its lake front for shipping purposes. Legislation was enacted at the last session of the general assembly, which contemplates turning over to the various park boards, practically all of our lake front for development and beautification as adjuncts of our park systems.

We are all proud of our splendid systems of parks and boulevards. We all want to see them grow, but no city, and particularly no strictly industrial and commercial city such as Chicago is, can thrive on beautification alone. Lake commerce played a large part in making Chicago what it is. I do not believe it wise to ignore entirely that advantage which Chicago has by reason of its location, and it is only a question of time when that advantage will be lost, unless we secure other harborage facilities than those afforded by the Chicago and Calumet rivers. If lake commerce cannot find convenient accommodation at Chicago, it will go to the harbors being developed just over the state line in Indiana, just as certainly as water runs down hill.

Practically all of our lake front that has not been already dedicated to park purposes is that comparatively short stretch of shore line lying between Twelfth St. and Jackson Park. Under the legislation enacted last spring this will also be turned over to the south park board as soon as the War Department gives its consent. Holding the views I do on this whole subject, I have asked the Secretary of War to withhold this consent until the city of Chicago can consider and determine whether it may not desire to use some portion or all of this shore line between Twelfth St. and Jackson Park for commercial and shipping purposes.

Consideration of this question of utilizing the lake front, as indicated, for shipping purposes, might properly include also consideration of the ever present, pressing railway terminal problem. While I have no fixed views on this part of the subject, I can see that it might be possible, in developing a harbor on the lake front as indicated, to acquire sufficient land, made by filling in the submerged land incident to building docks and breakwaters, which might serve railway terminal purposes. This, however, is simply incidental to the main proposition.

Following this communication the city council authorized the mayor to appoint a commission of five members to study the questions raised and appropriated $5,000 for the investigation.

Representatives of the Commercial Club, and Mr. Burnham as well, state that the plans being made by the latter will provide ample harbor and wharfage facilities for fifty years hence, and will also make provision for railway terminal improvements. Additional harbor facilities are contemplated at the mouths of the Chicago and the Calumet rivers. It is urged that a harbor at the latter point would be particularly serviceable for through shipping, while docking facilities at the river mouth and wharfage along the river itself are best suited to strictly local needs.

We are indebted to Lieut.-Col. W. H. Bixby, Corps of Engineers, U. S. Army, U. S. Engineers' Office, Chicago, Ill., for bringing the foregoing-mentioned matters to our attention, and for sending us a copy of his report* of May 22, 1906, on the "Effect of Withdrawal of Water from Lake Michigan by the Sanitary District of Chicago," in the course of which are made a number of statements pertinent to the use of the Chicago River for harbor purposes. The gist of these statements is that the lake front rather than the Chicago River is the proper place for a harbor, and that a harbor can be developed on the lake front at less cost to the Government than in the river. Colonel Bixby urges that the river cannot serve adequately more than one of the threefold purposes to which some are seeking to devote it: (1) harborage and wharfage; (2) a means of sewage disposal for Chicago; (3) a through navigation route. The reason for this is the rapid currents in the river where the channel is partially blocked by large boats. As an extreme illustration: If a boat be tied at a wharf on each side of the river and at the same time and place two boats meet in the river the current in the South Branch, when carrying 8,000 cu. ft. per sec. of drainage flow, would be increased to 3.6 miles per hr. or 5.3 ft. per sec. This, in a winding channel, only 200 ft. wide, would be out of the question, and even the conditions due to two boats abreast are considered undesirable, if not impracticable.

Some discussion of the points already mentioned and of others as well, is given in the editorial columns of this issue.

*To Brig.-Gen. A. Mackenzie, Chief of Engineers, U. S. Army, Doc. No. 6, 59th Congress, first session, Committee on Rivers and Harbors, House of Representatives, U. S.

THE PROBABLE END OF THE ASHOKAN RESERVOIR DAM AWARD CONTROVERSY.

The long controversy over the award by the Board of Water Supply of New York City of the contract for the main dams of the Ashokan Reservoir to other than the lowest bidder (see Eng. News, Jan. 2, 1908) appears to have been brought to an end by an opinion submitted to the mayor of New York by the corporation counsel. The opinion declares that the recent report of the Commissioners of Accounts gives no ground, under the law, for charges against the members of the Board of Water Supply. The question at issue is of so much importance to other boards charged with the execution of public works, as well as to engineers and contractors, that we reprint the opinion in full, as follows:

Jan. 20, 1908.

Hon. George B. McClellan, Mayor.

My Dear Sir: In reply to your verbal request for an opinion in regard to the matters connected with the award of the contract for the construction of the Ashokan Dam by the Board of Water Supply, I beg to say I have very carefully gone over all the papers connected with this subject, and have been much assisted by the very thorough examination and report by the Commissioners of Accounts who, under your direction, have investigated so carefully all the facts. As a result of that investigation many things have become known which may not have been known at the time, and as a result it may be, in the light of new information, different conclusions might have been reached. Be that as it may, the question I am now concerned with is quite different, and relates exclusively to the question of law arising in connection with the matters discussed. In my opinion given to you under date of Oct. 3, 1907, I said:

The Board of Water Supply was appointed under authority of Chapter 724 of the Laws of 1905. Section 29 of that statute is as follows:

"Section 29. After the expiration of the time limit in the advertisement the said bids or proposals shall be publicly opened by the said Board of Water Supply, and it may select the bid or proposal the acceptance of which will, in their judgment, best secure the efficient performance of the work, or they may reject any or all of such bids."

It is perfectly clear from this section of the statute that the Board of Water Supply is at liberty to accept any bid which, in its judgment, will best secure the efficient performance of the work, even the highest bid.

I do not see how there can be any doubt of the right of this board to select MacArthur Brothers Co. and Winston & Co. as the contractors, if the acceptance of their bid will, in the judgment of the board, best secure the efficient performance of the work.

Similar provisions exist in other statutes, so that the granting of authority for the making of contracts with other than the lowest bidder is not unusual, and many instances could be cited in which such contracts have been let.

The question of the advisability of letting the contract for this great and extraordinary work, so urgently needed and so important to the interests of the city, to a contractor not the lowest bidder is not a question of law, but a question the answer to which depends upon a multitude of facts and circumstances.

The statute has placed the power of determining this question in the Board of Water Supply. This involves a great responsibility.

If the board failed to wisely exercise the discretion thus vested in its members by statute, it would evidently be subject to grave criticism.

Very broad powers are given to the Board of Water Supply, and it was evidently intended that it should have the power of letting contracts, particularly without the concurrence of any other board or city officer.

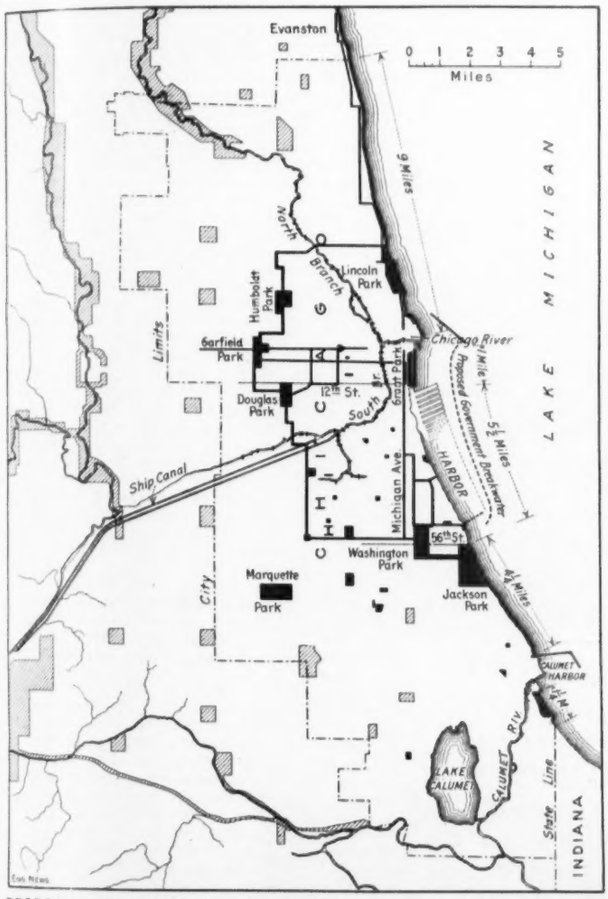
I see no reason to in any way modify the views above expressed. There can be no doubt, therefore, in my judgment, that the Board of Water Supply acted entirely within its powers when it assumed to determine the question whether or not it was for the best interests of the city to let the contract to other than the lowest bidder. That very broad powers were intended to be given to the Board of Water Supply is further accentuated by the fact that the liability to removal, which is the only method of control prescribed by the act, is strictly limited by the express terms of the statute, which provides:

> No member of said board shall be removed except for incompetency or misconduct shown after a hearing upon due notice, upon stated charges.

Taking the whole statute together, it is entirely evident, I think, that it was the intention of the Legislature to vest great powers and a wide discretion in the board, and at the same time and as an adjunct of such large power to strictly limit the right of removal to specific cases involving personal wrongdoing on behalf of the members; "misconduct," as used in the statute must be held, in my opinion, to mean wilful, conscious wrongdoing, or such gross negligence as will be tantamount to wilful wrongdoing. Errors in judgment, or the fact that the board came to an erroneous conclusion as to any matters it was authorized to pass upon, are strictly eliminated by the statute as grounds for removal. In this respect there is a very marked distinction between this statute and the provisions of the charter vesting absolute power of removal in the Mayor, and I think it clear that the Legislature intended to make this distinction and to limit the right of removal to cases in which the Mayor, after a hearing and on formal charges, should judicially find the existence of the specific causes mentioned in the act as a prerequisite to the power of removal.

It is apparent that a very serious difference of opinion has developed as to whether the conclusion of the board not to award the contract for the Ashokan Dam to the lowest bidder was wise or for the best interests of the city. I understand that the members of the board still adhere to their conclusion that the course pursued by them was a wise one. Whether or not, in view of all the facts as now apparent, such conclusion was wise is immaterial for the purposes of this opinion. The question presented to me is whether the facts and evidence justify the charge of incompetency or misconduct within the meaning of the statute. There is no suggestion on behalf of anybody reflecting upon either the integrity or the motives of the members of the commission, and after a very careful consideration of all the circumstances I am of opinion that, as a matter of law, the evidence and facts do not warrant the preferment of charges against the members of the board.

Yours very respectfully,
F. K. Pendleton, Corporation Counsel.



PROPOSED NEW HARBOR FOR CHICAGO IN RELATION TO WATER-FRONT PARK IMPROVEMENTS.

(Heavy lines along shore show portions of lake front which may be used for park purposes. Portion enclosed by line marked "Proposed Government Breakwater" and along lake front from 12th St. to 56th St. should be used, Mayor Busse claims, for harbor instead of park purposes.
Existing parks are shown in solid black, and boulevards connecting them by solid black lines. Proposed new park sites are shown by hatched areas.)

NOTES FROM ENGINEERING SCHOOLS.

CARNEGIE INSTITUTION FOR SCIENTIFIC RESEARCH.—It was recently announced that Mr. Andrew Carnegie had added $2,000,000 to the $10,000,000 endowment fund. The trustees of the institution have allotted about $530,000 for the prosecution of scientific inquiry in 1908. A building will be erected in Washington to accommodate the administrative offices which are now in rented quarters.

NORTHWESTERN UNIVERSITY.—It is reported that the new engineering building will be ready for use in the fall of 1908. This building stands on the lake shore northeast from the library. It is 126 × 58 ft., with three stories and a basement. The walls are of buff sandstone faced with pressed brick on the interior. The first floor will be made up of a large entry hall, large lecture room, hydraulic laboratory and offices. In the basement will be the general mechanical and electrical machine laboratories and on the upper floors will be the department library, drawing and recitation rooms and the faculty offices. The building was given by Mrs. Gustavus F. Swift and is expected to cost $100,000.

FORTY MINERS NARROWLY ESCAPED DEATH by suffocation or explosion in the Catsburg mine of the Monongahela River Consolidated Coal & Coke Co., at Monongahela, Pa. It is reported that a fire was started, about 2½ mi. from the mouth, by a "blowout" shot fired by the quitting day shift, and these 40 men, farther back in the mine workings, were cut off from the main entry. Escape was effected through seven miles of unused passages to an opening at Charleroi. It is stated that the mine formerly was very gaseous and that two years ago an explosion killed five men. A new ventilating system was installed at that time at the direction of the state inspector.

THREE MINERS ENTOMBED on Dec. 4, in the Alpha Mine shaft of The Giroux Consolidated Mines Co., near Ely, White Pine County, in the heart of the low-grade copper deposits of Eastern Nevada, were rescued on the evening of Jan. 18, after 46 days imprisonment 1,000 ft. below the surface. On the morning of Dec. 4 four men were working at the bottom of the shaft (1,085-ft. level) and the pumpman was at the pump station on the 1,000-ft. level. The bottom of the shaft was reached from the pump station by a series of ladders, and when the cave-in started the men attempted to gain the upper level by climbing through the shower of timbers, rocks and earth that fell about them. Two were knocked back and killed, but two reached the pump station safely. While the shaft was caving the pumpman was telephoning the engineer in the shaft house above to shut off pressure from the steam pipes, as it was blowing the station full of fine dust. Immediately after this telephonic communication was interrupted, but this was restored later at the direction of the mine electrician by connecting the instruments to the power cables running to the electric pump. While the telephones were out of service a six-inch water pipe was used as a speaking tube. The imprisoned men took a gate valve and several feet of pipe off this line, allowing food and water to be lowered and received. The mine master mechanic devised a train of 12 carriers, made from two-inch pipe nipples and caps, connected together with eyebolts and flexible connections. An attempt was made to furnish compressed air through the steam pipes, but this merely blew dust into the station owing to a break in the line. The six-inch pipe was used for the air supply at times when not in service for lowering food and water. During these 46 days the work of rescue was pushed as rapidly as possible. A considerable portion of the shaft was found so filled by a rammed mass of timbers, rocks and earth that clearing was difficult.

THE PANAMA CANAL LOCKS are to be made 110 ft. in width, to provide for possible increase in the size of naval vessels in the future, in accordance with an expressed opinion by the General Board of the Navy. The Canal Commission refers to the opinion of the naval officials and has submitted an estimate of the cost of locks 100 ft. wide amounting to $52,580,000 and of locks

110 ft. wide at $57,091,000. The larger locks will require somewhat more water and a longer time for operation; but any deficiency in the supply from Lake Gatun for lockage during the dry season can be made up by constructing a dam at Alhajuela. The date of completion of the canal will really be fixed by the time necessary for constructing the locks, since very rapid progress is being made on the Culebra cut. The total excavation from the Culebra cut in 1907 was 9,177,000 cu. yds., and there still remains to be removed 44,800,000 cu. yds. At the present rate of progress this material can easily be taken out in less than five years.

Highest Daily Shovel Record.—The largest daily output by steam shovels in the Culebra Division since work was commenced by the United States was 46,732 cu. yds. on Dec. 31, 1907. Forty-three shovels were at work on that day, of which two were 45-ton, ten 70-ton, and thirty-one 95-ton shovels. The average output per shovel for all shovels on the work for the eight-hour day was 1,086½ cu. yds. In handling this material the following cars were loaded: 1,451 Lidgerwood flats, 1,104 Western dumps (small), 248 Western dumps (large), a total of 2,803 car loads. The total number of trains handled on this day was 347, and the total number of locomotives in use for all purposes was 130.—"Canal Record."

THE NUMBER OF RAILWAY TIES purchased by steam and electric railways during 1906 was 102,834,040, and the average cost 47 cts. per tie, according to a recent bulletin of the Forest Service of the U. S. Department of Agriculture. The purchases by steam railways represented nearly 90% of the total, and about 75% were hewed, only 25% being sawed ties. The purchases of treated ties amounted to 5,289,435. In addition to these, however, 6,490,200 ties were treated by the railways at their own plants. The electric railways used 641,000 treated ties, 124,680 of which were treated by the railways after purchase. The different kinds of wood used were as follows:

Kind of Wood.	Total.
Oaks	45,357,874
Southern pines	18,841,210
Douglas fir	7,248,562
Cedar	7,083,442
Chestnut	6,588,975
Cypress	5,104,496
Western pine	3,969,005
Tamarack	2,576,859
Hemlock	2,058,198
Redwood	1,248,629
Lodgepole pine	554,738
White pine	373,387
All others	1,828,067
Total	102,834,042

LOCK JOINT CONCRETE PIPE is being used on the salt-water trestles of the Charlotte Harbor & Northern Ry., in Florida, to protect the piling against the teredo and other marine borers. The structures being protected include the Gasparilla Sound bridge, two miles long, the Myakka River bridge and the Coral Creek bridge, half a mile and one-fourth mile long, also the piling for the new wharves and other terminal structures at Boca Grande. The lock-joint system is controlled by the Lock Joint Pipe Co., of 346 Broadway, New York City, and was described in our issue of Jan. 4, 1906.

PERSONALS.

Mr. J. M. Flagler has retired from the presidency of the Campbell-Flagler Bridge Co., of Council Bluffs, Iowa, and has removed to Colorado Springs.

Mr. Chas. E. Bolling was elected City Engineer of Richmond, Va., on Jan. 6, to succeed the late W. E. Cutshaw. For the past two years Mr. Bolling has been Superintendent of Water-Works and for 12 years previous to that was assistant to the City Engineer.

Mr. George Weston has been appointed as the city's representative on the Traction Board of Supervising Engineers, of Chicago. He has been Assistant to the Chief Engineer (Mr. Bion J. Arnold) and now takes the place of his brother, Mr. C. V. Weston, resigned.

Mr. St. George H. Cooke, who has been for the past two years Resident Engineer in southwestern Virginia for the Tidewater (now the Virginian) Ry., has opened offices in the Cambridge Building, Chester, Pa., for the transaction of a general engineering business.

Mr. Marsden Manson, M. Am. Soc. C. E., has been elected City Engineer of San Francisco by the Board of Public Works. Mr. Manson has for many years been a consulting engineer in San Francisco and has particularly interested himself in the city's water supply.

The Chicago Harbor Board appointed by Mayor Busse to investigate the merits of the lake-front harbor projects, includes the following engineers: Isham Randolph, Consulting Engineer to the Sanitary District; John M. Ewen, and F. A. Delano, the latter representing railway interests.

Mr. J. H. Granberry, Assoc. M. Am. Soc. C. E., has returned from the Philippine Islands where he was engaged as Supervising Engineer for J. G. White & Co. on the naval coaling station at Olongapo and has accepted a position as engineer with Bull & Mitchell, steel experts, at No. 120 Liberty St., New York City.

Mr. J. Francis Le Baron, M. Am. Soc. C. E., who has just returned from an examination and surveys of the Prinzapolca River, Nicaragua, has been retained by the Board of Trade of the city of Westminster, British Columbia, to make an examination and report on the improvement of the navigation of the Fraser River.

Mr. Walter S. Morton, M. Am. Soc. C. E., who until recently has conducted a general consulting practice in Hartford, Conn., and Mr. Wilmont W. Burritt, who has had considerable experience as a metallurgist and analytical chemist, have combined forces and have opened offices as consulting engineers at No. 2 Rector St., New York City.

Mr. Morris McDonald has been elected Vice-President and General Manager of The Maine Central R. R. to succeed the late Geo. F. Evans. Morris McDonald was born in 1865 and entered railroad work in 1883 with the Kentucky & Indiana Bridge Co. From 1885 to 1892 he was with the Louisville, Evansville & St. Louis R. R. In 1896 and 1897 he was secretary to the late Geo. F. Evans, and since 1897 has been General Superintendent of the Maine Central.

Messrs. H. G. Balcom and Wilton J. Darrow, Assoc. M. Am. Soc. C. E., have opened offices as consulting engineers, under the firm name of Balcom & Darrow, at No. 314 Madison Ave., New York City. Mr. Balcom was formerly Engineer-in-Charge of structural design for the American Bridge Co. in New York and Pittsburg, and for the last three years has been structural engineer for the architects in the design of the new Grand Central terminal in New York. Mr. Darrow has been associated with him as assistant engineer in both of the above positions.

Obituary.

George Vaux Cresson, President of the George V. Cresson Co., engineers, founders and machinists, died Jan. 18, at his country residence, Caversham House, near Elkins Park, Pa. He was born in Philadelphia, Sept. 10, 1836. He established the firm of Cresson & Hubbard at Twelfth and Noble Sts., Philadelphia, in 1859. In 1866 the firm became Cresson, Hubbard & Smith, and in 1892 it was incorporated as the George V. Cresson Co. Mr. Cresson was a member of Franklin Institute, a past-president of The Manufacturers' Club, a member of the Engineers' Club of Philadelphia, and many social and commercial bodies.

Charles Hermany, Past-President of the American Society of Civil Engineers, died at his home in Louisville, Ky., on Jan. 18. He was born in Lehigh Co., Pennsylvania, on Oct. 9, 1830, and after a public school education in his home county, moved, in 1853, to Cleveland, Ohio, where he entered the office of the City Engineer. From Cleveland he went to Louisville in 1857 and became connected with the Louisville Water-Works. On Jan. 1, 1861, he was appointed Chief Engineer and Superintendent of the Water-Works, which position he held continuously until his death, a period of over 47 years. On the occasion of his election as President of the American Society of Civil Engineers in 1904, Engineering News published a photograph and biography of Mr. Hermany, which appeared in the issue of Jan. 28, 1904.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 20-25. Fourth annual convention at Buffalo. President, Richard L. Humphrey, 1001 Harrison Bldg., Philadelphia, Pa. Convention Manager, Dal H. Lewis, 700 Main St., Buffalo.

NATIONAL SOCIETY FOR THE PROMOTION OF INDUSTRIAL EDUCATION.
Jan. 23-25. Annual meeting at Chicago. Secy., C. R. Richards, Columbia University, N. Y.

CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 28-30. Annual meeting at Montreal. Secy., Prof. C. H. McLeod, 877 Dorchester St., Montreal.

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Feb. 3-8. Annual meeting at Columbus, Ohio. Secy., Theo. A. Randall, Indianapolis, Ind.

AMERICAN CERAMIC SOCIETY.
Feb. 3-5. Annual meeting at Columbus, Ohio. Secy., Edw. Orton, Jr., Columbus, Ohio.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 11-12. Annual meeting at New Haven. Secy., T. F. Jackson, New Haven.

OHIO ENGINEERING SOCIETY.
Feb. 11-13. Annual meeting at Columbus. Secy., E. G. Bradbury, 85 North High St., Columbus.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 18. Annual meeting at New York. Secy., R. W. Raymond, 29 West 39th St., New York.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—For the annual meeting at Montreal, Jan. 28-30, the following program has been published:

Tuesday, Jan. 28.—At the rooms of the Society, 413 Dorchester St. West, Montreal.
(10 a. m.) Meeting for the nomination of scrutineers, receiving the report of Council, and transaction of the general business of the Society. (1 p. m.) Adjournment for members' luncheon in the rooms of the Society. (8.15 p. m.) Address by the retiring President, Mr. W. McLea Walbank. At the conclusion of the President's address, an exhibition of lantern views illustrating the Quebec Bridge, will be given by Mr. Henry Holgate.
Wednesday, Jan. 29.—The members are invited to visit the works of the Lakefield Portland Cement Co., Ltd., at Pointe aux Trembles, the new power-house of the Montreal Street Railway, and the foundry of Warden King, Ltd., Maisonneuve.
(7.45 p. m.) Annual dinner in the Windsor Hotel.
Thursday, Jan. 30.—(10 a. m.) Meeting for the reception of reports of scrutineers and conclusion of the business of the annual meeting. (2.30 p. m.) Meeting of newly-elected Council.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—Mr. W. S. Murray, Electrical Engineer, New York, New Haven & Hartford R. R., presented a paper at the 224th meeting, New York City, Jan. 10, 1908, on "The New Haven System of Single-Phase Distribution with Special Reference to Sectionalization." The alternative distributing systems which were considered were briefly outlined before the accepted plan was described. These alternatives were in brief: (1) 11,000-volt, three-phase generation, transmission along right-of-way at 11,000 volts, step-down transformation furnishing current to the trolley wire at 3,300 volts, track mileage divided into three equal sections for the three phases; (2) same arrangement as (1) except 6,600 trolley voltage; (3) 11,000-volt, three-phase generation at power-house, 11,000-volt transmission, track mileage divided into two equal sections, each having its trolley wire connected to one of the three terminals of the power-house bus-bars, the tracks for both sections connected to the remaining power-house bus. The scheme adopted was: (4) 11,000-volt, three-phase generation, 11,000-volt transmission, only one phase applied to all sectionalized trolleys throughout the zone, three-phase distribution also carried throughout the zone, to be available for polyphase motors in railway machine shops and for motor-generator sets in local direct-current railway plants owned by the New Haven Road. (This system was described at length in Engineering News, Sept. 5, 1907.) Mr. Murray outlined the advantages in making a small number of long track sections, instead of a larger number of short ones. These were: (1) Co-terminus signal-tower scheme more easily arranged, (2) fewer switches to maintain, (3) more reliable action due to less chance of grounding of line, (4) lower first cost. The disadvantages shown were: (1) Increased difficulty in locating grounds, (2) greater section of dead track in case of trouble, (3) larger section circuit-breakers required. Mr. Murray stated that unexpected difficulties had been encountered which, however, could not be viewed as a menace to the principles of the scheme adopted. All such troubles had either been removed or their easy solution was in sight. In the six months of operation many valuable data have been collected and on such experiences Mr. Murray made ten recommendations for single-phase traction work: (1) In one, two, three or four-track systems the distribution should include by-pass wires. (2) Electrical sections should not average less than 1.5 mi. in length; greater average lengths are acceptable and individual lengths should be governed by local conditions. (3) A safe working distance between trolley and rail is 22 ft. (4) The de-insulating effect of steam locomotive discharges is a most important consideration. (5) High insulation safety factors should be used where high-tension construction is brought nearer the rails than 22 ft., as for low bridges. Strong mechanical shields should be used to deflect locomotive blasts from insulators at low bridges. Wherever possible all insulators should not be installed in the direct line of the locomotive blast. (6) Auxiliary wires where they cannot be carried over highway bridges as aerial conductors should be in lead-covered cables with end-bells properly housed. (7) All main circuit breakers connecting feed wires to bus-bars should be equipped with time relays so that any short circuit will first open the section circuit breakers thus locating the trolley section grounded. (8) On account of the influence of weather and locomotive stack discharge, all section oil-switches should be installed in switch-houses at the side of the track with lead-covered cable to trolleys. (9) Signaling should be arranged so that the operator can prevent the engine-runner from spanning two sections in event of one being grounded. (10) All towers should have a telephone service immune from electromagnetic and static disturbances.

Mr. E. F. Alexanderson, Electrical Engineer, General Electric Co., Schenectady, N. Y., presented a paper on "A Single-Phase Railway Motor." In this the electrical characteristics of a new alternating current motor were described. This motor has been called a series-repulsion motor though it is really neither, and while it embodies many electrical features of both types yet it is truly neither compensated series or repulsion. The compensated series commonly comprises an armature, a field and a compensating winding, while the repulsion motor commonly consists of a short-circuited armature in a rotating magnetic field flux. In this motor the windings most resemble those of a series motor; the armature and stator are permanently in series. In starting the armature is short-circuited and full voltage is applied to the field windings. On account of the relation of the number of rotor and stator turns twice as much current flows in the short-circuited armature as in the fields, giving a higher torque than is usual in repulsion motors. In the running connection the armature is not short-circuited and part of the power is introduced to the field and part to the armature.